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ENGINEERING NEWS.

AT THE ROYAL DOCK YARDS OF GREAT BRITAIN there were launched in 1889 22 vessels with an aggregate displacement of 36,155 tons and an aggregate engine equipment of 89,400 I. H. P.

Of these vessels 13 were gunboats and torpedo boats of about 800 tons displacement; 7 were cruisers of about 1,500 tons displacement, and only two, the *Blake* and *Vulcan*, were vessels of extraordinary size and power. The *Blake* is a protected cruiser, and when fully equipped will be the most powerful vessel of her class afloat. She has a displacement of 9,000 tons and is 375 ft. in length. With natural draught she is expected to develop 13,000 I. H. P. and make a speed of 20 knots. With forced draught 25,000 I. H. P. will be developed and a speed of 22 knots is expected. The *Vulcan* is a vessel of 6,620 tons and is built for a torpedo boat depot. She will have facilities for the transport of 9 second-class torpedo boats.

Besides the above work, the keels of 12 new vessels were laid during the year, including 3 battleships of 14,150 tons displacement and a cruiser of 7,350 tons, and a large amount of repairing and refitting was done.

AMPLE APPROPRIATION FOR THE HAY LAKE CHANNEL and St. Mary's River improvements are being urged upon the River and Harbor Committee of Congress. Representatives of Sault Ste. Marie, Duluth and Cleveland recently had a hearing before the committee and stated the urgent need for the work's early completion. Many schemes brought before the River and Harbor Committee deserve far less consideration than they receive; but in the case of this improvement there is no question but that it is a work of great public importance, and ample funds should be furnished for its early completion.

DEEPENING SOUTHWEST PASS at the mouth of the Mississippi by means of jetties is urged upon Congress in a memorial from the New Orleans Board of Trade. The present South Pass, made navigable by Captain EADS' famous work, is now the only entrance to New Orleans for vessels of any considerable draught, and it is said that in case of the accidental collision and sinking in this narrow channel of a large steamship the commerce of the port would be effectually cut off. It is to be considered on the other hand, that the effect of opening the Southwest Pass might be soon made evident in a shoaling of the South Pass, on which so many millions have now been expended. It would contribute far more to the improvement of the port of New Orleans if the present South Pass channel could be deepened and made safely navigable for ships of a larger draught than can now pass through it.

THE KEEL OF CRUISER NO. 7 was laid on Jan. 29 at the Brooklyn Navy Yard. The new vessel will be 300 ft. long, 42 ft. beam, 18 ft. draught, and 3,000 tons displacement. Her cost is limited to $1,100,000. Her armament will be one 6-in. breech-loading rifle, and ten 4-in. rapid-fire guns, besides smaller arms, and six torpedo tubes.

THE NICARAGUA CO. has been incorporated in London, England, with a capital stock of $1,000,000. The object of the company is to buy out the Managua Lake Navigation Co. and the Managua Water-Works Co., to acquire the El Cavario and La Republica gold mines, also to acquire concessions for a market, a street railway and water works in Masaya, and for supplying water to Jinotepe, Masatepe, San Marcos and Diriamba. The incorporators are W. G. HUGHES, J. EUSTACE and T. DONALD, of London; A. VIANO and C. CHEVALLEY, of PARIS; P. GUISTO, of MANAGUA, and W. CHINIE, C. E., of Masaya.

THE FORTH BRIDGE was tested Jan. 21. The official report is as follows: "Sir JOHN FOWLER and Mr. BAKER, engineers of the Forth Bridge, have to-day tested the two 1,700 ft. spans by placing on the centres two trains, each made up of fifty loaded coal wagons and three of the heaviest engines and tenders, the total load thus massed upon the span being the enormous weight of 1,800 tons, which is more than double what the bridge will ever be called upon in practice to sustain. The observed deflections were in exact accordance with the calculations of the engineers, and the bridge exhibited exceptional stiffness in all directions." The London *Railway News* says the trains were each arranged with two engines in front and one in rear, the length of train being about 1,000 ft. As the north and south cantilevers measure each above 1,500 ft. over all, and the Inchgarvie cantilever is 115 ft. longer; the trains, when centred on the piers, filled up about two-thirds of their length. When the head engines reached the end of the central or suspended girder, the tail engines had left the centre of the cantilever, the entire weight being thus thrown upon the arm and centre girder. The load put on the bridge was more than double what will ever be upon it in practical use, but it indicates the vastness of the structure to learn that even this exceptional load only amounted to 10 per cent. of the gross weight of each cantilever, and about 3 per cent. of the entire bridge. In regard to wind pressure, it is stated that during a recent heavy gale, when the wind-gauges on Inchgarvie recorded a pressure of 37 lbs. per sq. ft., the maximum lateral movement of the centre cantilever was less than 1 in. The bridge is to be formally opened by the Prince of Wales on March 4.

THE DISTRIBUTION OF COMPRESSED AIR at Birmingham, England, is now in satisfactory operation. The enterprise was chartered in 1884, but various causes have operated to delay the completion of the works, and even now only about four and a half miles of mains have been laid. At the central station there are now three air-compressors at work, each of 1,000 I. H. P., with an auxiliary engine of 150 H. P. for Saturday afternoon and night work. Steam is supplied by 10 water-tube boilers, gas fired. The pressure in the mains is 45 lbs. per sq. in. The air is already taken by 26 consumers, and so many others are preparing to make connections that the engine power will shortly have to be increased. The largest engine worked by the air develops over 50 H. P., and the uses of the air in the various shops are very numerous. A refrigerating chamber is being erected to enable the air to be used for the preservation of meats.

THE LATE JAMES PRESCOTT JOULE is to be commemorated by an international memorial. The movement has been started by the Council of the Royal Society of Great Britain, and Sir HENRY E. ROSCOE has been appointed secretary of the fund. Contributions may be sent to the International Joule Memorial, Royal Society, Burlington House, London.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of a freight train on the Texas & Pacific Ry., near Seymourville, La., on Jan. 30. The engine struck a cow, and the engine and 13 cars were derailed. The wrecked cars caught fire and were destroyed. Two men were killed.——Another serious derailment occurred Jan. 31, on the Kilkenny Lumber R. R., near Lancaster, N. H. A train with twelve lengths of timber was coming from Kilkenny, and breaking apart on the steep grade, the engineer endeavored to keep out of the way of the rear section. When rounding a curve the engine left the track, plunging into the bank and burying the engineer and brakeman in the wreck; the fireman saved himself by jumping.

BRIDGE ACCIDENTS are reported as follows: On Feb. 3 the first span of the iron bridge of the Ohio, Indiana & Western Ry., at Bridge Junction, Ill., gave way under a freight train, throwing the engine and three cars into the river. Three men were killed.——On Feb. 2 a bridge on the Oregon Ry. & Navigation Co.'s line near The Dalles, Ore., gave way under a construction train. Ten men were killed.——In California, the floods have wrecked and damaged several railway and highway bridges.

THE PROPERTIES OF GASOLINE have been illustrated very close to Altoona by an explosion in which one man was fatally and four others seriously burned. In filling a large tank at Gallitzin one man was overcome by gas, another went to his assistance with a lighted lamp, and a terrible explosion followed, with the stated result. What the tank was there for is not stated, nor does it matter. The essential fact is that the habitual handling of gasoline in large quantities is fully as dangerous as similar handling of dynamite, and begets even more accidents.

THE EXTENSIVE SNOWFALL on the Pacific Slope has caused serious blockades of the railways. Many trains have been snowed in, and mails and traffic have been delayed. The rotary snow plows have done good service, and where they have not been available, the ordinary snow plows, with numerous engines behind them, have been used. Two steam plows, a rotary and a cyclone, were disabled by the heavy work and had to be laid off for repairs. Hundreds of men were engaged as shovelers.

THE JULL SNOW-PLOW made a good record in the blockade on the Oregon Short Line division of the Union Pacific. The plow left Granger, Wyo., on Jan. 16. Drifts along the line were from 5 to 20 ft. deep, but Baker City, Ore., was reached on Jan. 19, and 10 passenger trains lying at that point, with 400 passengers, were released from the blockade. La Grande, 640 miles from Granger, was reached at 3 P. M., Jan. 20.

THE COLORADO CANON SURVEYING PARTY are all well, as direct dispatches of date Jan. 23, sent out by a prospector, show, and were two weeks since at the head of the Granite Gorge, or well down the Grand Cañon. The Denver *Times* receives a scoring from its contemporary, the *Republican*, which seems not wholly undeserved, for spreading the report on very slim authority, without prior investigation. We may now fairly hope to have reports of the survey complete in about a month more.

PRACTICAL WORK IN FISH CULTURE is to be undertaken by the New York, Ontario & Western Ry. General Passenger Agent ANDERSON has applied to the New York State Fish Commission for 346,000 brook trout fry to stock streams in Delaware and Sullivan counties, N. Y., adjacent to the line of the road, and for 25,000 bass fry for stocking Silver Lake in Sullivan Co. These localities are favorite resorts for sportsmen and city tourists, and the railway company desires to foster this profitable passenger traffic. The New York & Northern R. R. has also applied for fry to stock streams in Westchester Co.

SOME INTERESTING ASPHALT TRIALS are being made in the streets of Berlin. The powdered material, instead of being merely stamped down by hand rammers, is strongly compressed by a 24-ton roller.

The roller reduces the thickness about 25 per cent. making a very compact and hard surface, which is expected to resist the wear and tear of the wheels much better than the less dense form commonly employed. It has been found necessary to use a somewhat bituminous powder, as otherwise the surface is apt to crack. In some streets, to avoid the offensive smell of the heated asphalt, the latter is being laid down in large plates after the manner of flag-stone paving.

HIGHWAY IMPROVEMENT IN OHIO is making a certain sort of progress. In a single day recently four bills were introduced in the Legislature, each having reference to the improvement of the roads of a single county. The Cleveland *Leader* points out that, while the introduction of these bills shows that public interest in the matter is being awakened, such special legislation is unwise, and a general highway law for the whole State is what should be enacted. 'Such a law should organize an intelligent force of roadmakers in every county, with a good county supervisor at its head, and should oblige all road taxes to be paid in cash.'

THE READING TERMINAL has been the all-absorbing question in Philadelphia the past week. On Feb. 4 a mass meeting of citizens was held in the Academy of Music, and resolutions were adopted demanding that the City Councils pass at once an amended ordinance permitting the Reading Ry. to make its terminal at Market St., instead of Arch St., and an ordinance for the construction of a belt line of railway along the 18 miles of water front of the city. The Railway Committee of Councils has already voted to recommend the ordinance for passage, and it seems probable that the privileges for which the Reading Co. has so long waited will soon be granted.

THE FORT ST. UNION DEPOT COMPANY, OF DETROIT, has begun proceedings for the condemnation of real estate on the site of its proposed structure; and it is stated that work is to be begun at once. Rumors are in circulation that among the companies which will run trains into the new station are the Canadian Pacific and the Pennsylvania.

A STEAM HEATING CONSOLIDATION of some moment is announced this week, GEORGE WESTINGHOUSE, Jr., and C. H. JACKSON, President and Vice-President, respectively of the Standard Car-Heating & Ventilating Co., of Pittsburg, Pa., becoming directors and large shareholders in the Consolidated Car-Heating Co., of Albany. The interests of the two companies are thus consolidated, which greatly extends the field of their operations for heating and ventilating cars and for lighting them by electricity. Automatic regulation of heat, which will obviate the complaints of the variable temperature of steam-heated cars, is also provided.

THE CHESAPEAKE & OHIO CANAL has been placed in the hands of HENRY C. WINSHIP and VIOTOR CUSHWA, as receivers appointed by Judge COX. They are to hold and manage the property subject to further orders of the court.

IMMIGRATION for the calender year 1889 was 426,738, against 518,526 the year before. For December it was 19,501, against 19,935 a year before, or almost exactly the same, indicating a tendency to renewed increase of immigration. The decrease last year was heaviest in Italian immigration, which few will regret.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS held their annual dinner at the Windsor Hotel in Montreal on Jan. 22. His Excellency the Governor General was present, together with a large attendance of members and their lady friends. Col. GZOWSKI, the President of the Society, presided, and speeches were made by the Governor-General Mr. HANNAFORD, Mr. LEPROHON and Col. GZOWSKI

OVER 4,000 TONS OF NICKEL is now the annual output of the Copper Cliff mine near Sudbury, Ont. This is a larger production than that of all other nickel mines combined. It is to be hoped that the increased production may result in a decrease in the price, now about 80 cents per pound, since the metal is now so largely used in plating the best class of mechanical work.

Physical Qualities of Aluminum Bronzes.

We recently took occasion to say, in discussing the question of the applicability of aluminum to the construction of transits, that the properties of the alloys of aluminum were as yet but imperfectly determined, the metal not having been cheap enough, until very recently, to make it of sufficient use in the arts to determine such properties exhaustively. A striking illustration of this fact has just come to us in the most curious specimen of ruptured material which we have ever seen, and also in the accompanying little diagram of the properties of certain aluminum bronzes and brasses, for both of which we are indebted to the courtesy of Capt. A. E. HUNT, of the Pittsburg Reduction Co. and Pittsburg Testing Laboratory.

The specimen referred to was a bronze of the following composition, which had elongated before rupture no less than 64.9 per cent in 3.9 ins. (1 cm.) *and* no less than 62.2 per cent., or nearly as much in 7.8 ins. (2 cm.).

Aluminum	6.32 p. c.
Copper	91.98 "
Silicon	1.18 "
Zinc	0.48 "
Total	99.96 "

This bronze would come near the upper end of the aluminum bronze line in the accompanying diagram.

The test of this bronze, as also the diagram showing results with other bronzes and brasses, was made by Prof. L. VON TETMAJER, of the Zurich Polytechnic School. The test piece was 12 mm. (0.472 ins.) in diameter, or of 0.175 sq. ins. area. Its elastic limit was 18,213 lbs. per sq. in., and its breaking strain 66,850 lbs. per sq. in., the reduction of area being 49.6 per cent., and the elongation the enormous amount given above, which was singularly uniform throughout the section, there being but very moderate local contraction at the point of rupture, and the whole surface of the test piece being greatly but uniformly roughened.

All the test pieces were prepared by, and the tests made for, the Aluminum Industry Co., Limited, of Newhausen, Switzerland. Having described in some detail the most extraordinary specimen of all, which we have seen and handled, the rest may be taken on faith, albeit greater effect from slight changes of composition has hardly ever been shown.

Considering the bronze line only, for example, it will be seen that a 5 or 6 per cent. aluminum bronze is one of marvelous ductility, combined with great strength. With every one per cent. of aluminum, however, the ductility rapidly decreases, while the strength notably increases, until at 11 per cent. there is practically no ductility left. The aluminum bronze has changed within that short range from the most ductile to the least ductile of materials. The same is in substance true of the aluminum brasses, the range not being so great, but the percentage of aluminum required to effect the change not being nearly so great, or only 2 per cent.

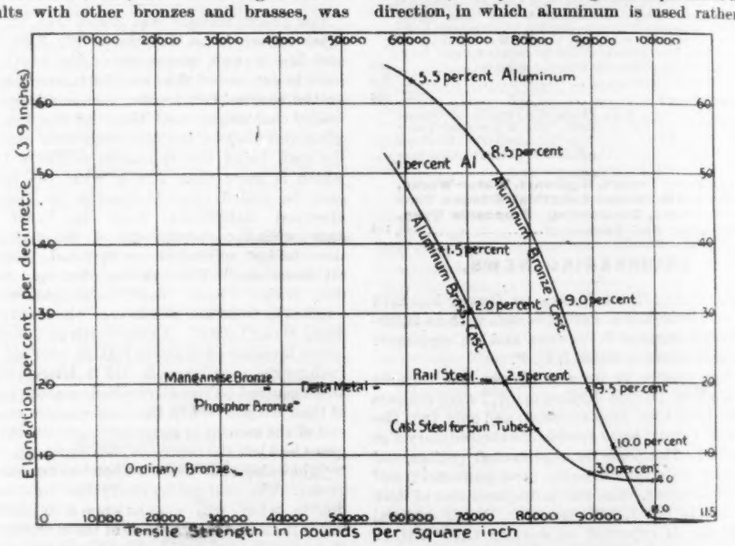


Diagram of Properties of Aluminum Bronzes and Brasses.

Constructed from Tests of Prof. L. von TETMAJER, of Zurich Polytechnic School.

To illustrate how extremely peculiar are the properties of these brasses and bronzes, certain familiar steels and bronzes are also shown on the diagram. It will be observed that all of the aluminum compounds shown are far ahead of the more familiar steels and bronzes in either strength or ductility, and most of them are far ahead in both strength and ductility. The very strongest and most ductile bronzes, however, as determined in Professor THURSTON'S hunt after "The Strongest of the Bronzes" some years ago, make a better showing than this, having elongations of 47 to 51 per cent., and ultimate strengths of nearly 70,000 lbs. These bronzes, however, are little used in the arts, and even these fall below the aluminum bronzes.

It is to be regretted that the curves of the diagram are not extended further to the left, so as to include all percentages from zero up, but this, with much fuller details, we shall hope to give later. In a general way, it is apparent that the curves are near their maximum altitude where they stop, and with still less aluminum would begin to descend. A pure copper (cast) has a tensile strength of some 30,000 or 22,000 lbs., and elongates 20 to 25 per cent., which brings it well down toward the lower left-hand corner of the diagram.

It is well known that small percentages of aluminum have a remarkable effect on the properties of iron and steel, as they do on copper, and there is, therefore, a very wide range for experiment in this direction, in which aluminum is used rather as a modifier of the properties of familiar materials than as a new material itself. There is, however, a wide range for experiment at the other end of the scale, viz.: where aluminum remains the preponderating material, but where alloys are added for the purpose of cheapening or improving it. For example, an admixture of 5 per cent. of silver, we are advised, has a remarkable effect to improve the quality of the metal for certain purposes, as metals for engineering instruments. Commercially pure aluminum, as now manufactured, has a specific gravity of about 2.6, an ultimate tensile strength of about 30,000 lbs., an elastic limit of about 24,000 lbs., and an elongation of about 10 per cent. in 8 ins. It should accordingly stand on the accompanying diagram somewhere between ordinary bronze and manganese bronze, or at no great distance "southeast" of pure copper.

This brings with it a curious consequence. Running the entire gamut of changes in the aluminum bronzes, between pure copper at one extreme and pure aluminum at the other, we should start a little "northwest" of manganese bronze, travel rapidly "northeast" to 4 or 5 per cent. aluminum; then descend still more rapidly "southeast" to the base line, at 11 per cent. aluminum; then (possibly) travel off "eastwardly" into space somewhere, as more aluminum is added; then come back again "westwardly" as still more aluminum is added, and finally travel "northwestwardly" to very near the point of beginning (but a little "southeast" from it), as we reached

pure aluminum, having metallurgically boxed the compass in a very surprising fashion. What does such seeming lawlessness mean, which yet must be underlaid by law?

Performances of the Best Modern Pumping Engines, Compared to that of the Cornish Pumping Engines in the Period of 1840.

By Prof. J. E. DENTON, Stevens Institute of Technology.

(*Continued from page 101.*)

THEORETICAL HEATING CAPACITY OF COALS USED IN THE TESTS.

Chemical analyses* of the anthracite coal used in the 72-hour test and of the bituminous used in the 24-hour test resulted as follows:

	Anthracite. Per cent.	*Bituminous.* Per cent.
Moisture	1.8	1.03
Hydrogen	4.60	5.85
Carbon	79.30	83.00
Sulphur	0.85	0.72
Oxygen	4.65	1.50
Nitrogen	1.90	1.45
Ash	6.90	6.45
	100.00	100.00
Ashes, clinkers, etc., by test	14.3	10.

Assuming that the excess of ash in the boiler furnace over that given by chemical analysis is unburnt carbon, we have the heat evolved by combustion as follows, in British thermal units:

	Anthracite.	*Bituminous.*
Hydrogen	25.12	36.60
Carbon	104.25	115.34
Sulphur	.33	.32
	129.70	152.26

Besides the moisture shown above, it is probable that each coal contained 3 per cent. more of moisture during the test, which dried out of the coal during the interval of a month intervening between the time of the test and that of the analysis. A sample of the anthracite coal dried over the boiler for 5 hours lost 3 per cent., but no similar determination was made in the case of the bituminous coal.

DISTRIBUTION OF THE HEAT EVOLVED BY COMBUSTION.

1. Each pound of moisture requires 1,100 heat units to evaporate it from 78°, the temperature of the boiler room, to steam at atmospheric pressure, and also 108 units to superheat the vapor to 428°, the temperature of the chimney. There would thus be consumed in heating the moisture in the fuel:

58 thermal units for the anthracite and
47 " " bituminous coal.

2. Each pound of anthracite coal evaporated 8.88 lbs. of water from 103°, temperature of feed, into steam at 126 lbs. gauge pressure, and similarly the bituminous evaporated 9.35 lbs. of water. There would thus be consumed:

9,919 thermal units for the anthracite, and
10,444 " " bituminous.

3. Chemical analyses of the chimney gases in the case of the anthracite gave the following percentages by volume:

No.	*Carbonic Acid.*	*Carbonic Oxide.*	*Oxygen.*	*Nitrogen by diff.*
1	8.2	0.4	9.4	82.0
2	8.5	0.4	12.1	79.0
3	9.5	0.0	10.9	79.6
Average	8.7	0.3	10.8	80.3

From these figures it follows that with the anthracite the loss of heating effect due to imperfect combustion by formation of carbonic oxide was 132 thermal units per pound of coal.

4. The above analyses of chimney gases give, for the average weight of air supplied per pound of carbon, 25 lbs., which is, roundly, equivalent to 20 lbs per pound of coal. Adding 0.85 lb., the weight of the combustible matter in a pound of coal, we have the weight of gases escaping by the chimney as 20.85 lbs. per pound of coal.

By measurement of the velocity of air entering the ash-pit doors, with an accurate Cassella anemometer, it was determined that the average velocity for all parts of the area of opening corresponded to the supply of 20.28 lbs. of air per pound of coal, to which the addition of the combustible matter being made, we have 21.13,† as the number of pounds of chimney gas per pound of coal. Taking 21 lbs. as the mean of the two methods of determination, we have the heat escaping by the chimney at 428° temperature = 1,954 thermal units per pound of coal. Summarizing these expenditures, we find the total for the anthracite is 12,263 units, leaving 12,970 — 12,063 = 907 units as the effect of radiation from the external surface of the boilers and from ash pit. Similarly the total for the bituminous is 12,577, leaving 15,226 — 12,577 = 2,649 units for radiation.

As the coal burned per hour was exactly 220 lbs. for both kinds of fuel, it is not reasonable to suppose that even twice as much radiation could occur with the bituminous as with the anthracite. Allowing one heat unit per hour per square foot of surface per degree difference of temperature as the radiation coefficient, and taking the average difference of temperature between the boiler surface and the atmosphere as 200°, the possible loss by radiation would be 150,000 thermal units per hour, the boiler surface being about 750 sq. ft. This amounts to 700 units per pound of fuel. It is therefore probable that the radiation loss for the anthracite is nearest correct; and that, therefore, the bituminous coal contained more moisture, gave more carbonic oxide than was found for the anthracite, and that the air per pound of coal may have been more, making the chimney loss greater.

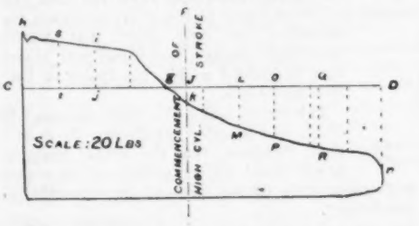


Fig. 26.—Fly Wheel Action, Low Cylinder.

C D represents Constant Water Pressure.

The probable distribution of heat may therefore be summarized as follows:

	Anthracite. Heat units.	Per cent.	*Bituminous.* Heat units.	Per cent.
Consumed in making steam	9,919	76.5	10,441	68.6
Lost in evaporating moisture	58	0.5		
Lost by imperfect combustion	132	1.0	3,878	25.4
Lost by chimney	1,954	15.0		
Lost by radiation	907	7.00	907	6.0
Total by chemical analysis	12,970	100.00	15,226	100.00

INFLUENCE OF THE FLY-WHEEL.

The lines *A B* and *C D*, Figs. 26 and 27, represent the constant resistance of the water reduced to the area of the high-pressure piston and low-pressure piston, respectively, and to the scales of the two cards. The water pressure is taken at 115 lbs. per sq. in., including the suction pressure. By the proportions of crank and connecting rods, etc., the low-pressure piston has made 0.45 of its stroke or is at *K F*, Fig. 26, when the high-pressure piston is on its dead centre or at *A*, Fig. 27. When the high-pressure piston moves from *A* to *G* there is evidently a surplus of force upon it equal to the ordinates of the area *A G I H*. Simultaneously the low-pressure piston moves from *J* towards *D*, and there is constantly a deficiency of force represented by *J K*, *L M*, *O P*, etc.

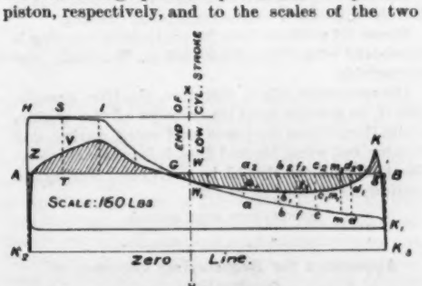


Fig. 27.—Fly Wheel Action, High Cylinder.

Shaded Area represents Excess or Deficiency of Steam Pressure; *A B* represents Constant Water Pressure.

Such deficiency must be supplied by the fly-wheel, and it may be conceived that to supply the deficiency of pressure represented by any particular ordinate, as *Q R*, the equivalent of this pressure is to be taken from the surplus pressure in the high-pressure cylinder at the ordinate *S T*. The high-pressure piston is at *S T* and its crank at an angle of 44° with the horizontal when the low-pressure piston is at *Q R*, and its crank at 134° from the dead centre, position *A*.

One pound of resistance in the low-pressure cylinder acts with a leverage against the high-pressure piston approximately equal to the ratio of the sine of the crank angle of the low-pressure cylinder divided by the sine of the crank angle for the high-pressure cylinder. Also because of the difference of area of the two cylinders and the scales of the two Figs., the length of *Q R* must be divided by 2 to apply it to Fig. 27. These ratios being properly used, it results that the deficiency of force *Q R* absorbs an amount of the surplus pressure *S T* represented by *S V*. This process being carried out for each ordinate *J K*, *L M*, *D U*, etc., gives the line K_2 *Z V G W*. The ordinate *A* K_2 represents *J K*, which, acting with a leverage of *D* against the steam surplus *A H*, reduces the effect of the latter to zero for the instant of passing the centre *A*.

The area *Z V G T Z*, minus *Z* K_2 *A* and minus *G W* W_2, represents the energy stored in the fly-wheel during the movement of the pistons from *A* to *W* and *J* to *D* respectively.

During the movement from *W* to *B* in the high-pressure cylinder, and *C* to *J* in the low-pressure, there is a surplus of force in the low-pressure cylinder represented by the ordinates *h C*, *s t*, etc., and a deficiency in the high cylinder represented by *W* W_1, *a* a_2, *b* b_2, etc. The value of the ordinates *s t*, *i j*, etc., being transferred to Fig. 27 in *f* f_1, *m* m_1, etc., so as to increase the pressures of the expansive curve, we have a line *G W a b d e k g* k_1, k_2. Ordinates a_1 a_2, b_1 b_2, may be conceived as pressures supplied by the fly-wheel to bring the force of the steam into equilibrium with the constant water pressure against the pumps. The sum of the shaded areas above the line *A B* represents energy stored in the fly-wheel, and the sum of those below this line represents an equal amount restored or given out by this wheel.

Fig. 28.—Effect on the Pawtucket Pumping Engine of Bursting a 6-inch and 12-inch Main; Fac-simile of Diagram on Edson Recording Gauge.

This energy is 3,520 ft. lbs. per stroke. The fly-wheel is 18 ft. in diameter, its rim weighs about 11,000 lbs., and the mean velocity of the latter is about 50 ft. per second.

If the only mass in the moving parts of the engine were the weight of the rim of the fly-wheel, the fluctuation of speed due to the above 3,520 ft. lbs. per stroke would be $\frac{1}{16}$ ft. per second,* or $\frac{1}{4}$ of 1 per cent. of the mean speed. It follows that the fly-wheel of the engine should be able to neutralize the irregularities of equilibrium between the steam pressure and the pump resistances so perfectly that no sensible variation of the speed of rotation can be detected. This conclusion is quite consistent with the apparent uniformity with which the fly-wheel rotates.

PROBABLE ACTION OF PAWTUCKET ENGINE IF WATER MAIN SHOULD BURST.

Line *a b c d e f* Fig. 28, is a fac-simile of the diagram of an Edson recording gauge during the bursting and repair of a 6-in. branch main of the Pawtucket system. This break occurred while the pump was running, and under the combined supply of the pump and reservoir the fall of pressure was too slight to sensibly disturb the work of the engine. A burst of the main at a 12-in. connection occurred at a time when the pump was not running, and caused the water pressure to drop to 30 lbs., as represented by the dotted line *g h*. To test the ability of the pump to control

* I am indebted to the courtesy of Dr. T. B. STILLMAN for these analyses.

† The brick setting of the Corliss boilers being almost entirely encased in iron, and the brick work being in excellent condition, no sensible leakage of air to the chimney could occur. The openings for air supply above the grate through the fire door amount to but one per cent. of the ash-pit openings, and are therefore neglectable.

* This was erroneously stated at $\frac{1}{16}$th per cent. in a previous issue.

itself during such a fall of pressure, the water pressure against the pump was reduced from 115 to 35 lbs. by opening a by-pass valve on the delivery pipe at the engine house. The time to accomplish this was 15 seconds, the valve requiring this interval for its manipulation. The result upon the engine was simply to cause its speed to increase from 49 to 52 revolutions per minute, or about 6 per cent. The action of the governor upon the steam distribution is shown in Fig. 29. It is warrantable, therefore, to conclude that the governor would protect the engine from dangerous action in case of any probable rupture of the pipe system.

NOTE ON THE FRICTION OF THE ENGINE MECHANISM.

In view of the very small loss of power due to friction found for the Pawtucket engine by comparing the steam and water indicator cards, it is desirable to check the showing of the latter by an estimate of the possible friction of the principal moving parts and of the work devoted to the air pump. It is not possible to satisfactorily estimate the friction of all of the moving parts even approximately; but, by aid of modern experimental investigations of the friction of engines, it is known that an estimate of friction according to MORIN'S laws, using values of the coefficient ranging from 5 to 10 per cent., agrees* fairly well with the friction as determined by aid of indicator cards and a dynamometer.

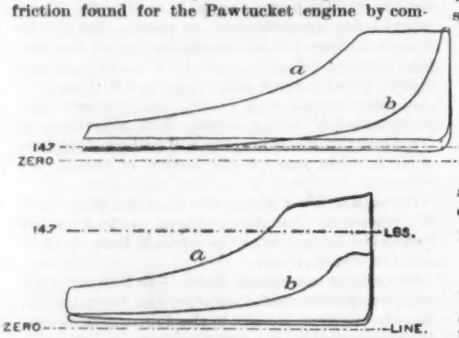


Fig. 29.—Action of Engine under Sudden Removal of Load.

Cards (*a*)—Water Pressure, 115 lbs.; Revs. per minute, 49.
" (*b*)— " " 35 " " " " 52.

The power devoted to friction and air pump as found above is from 5.13 to 7.21 H. P.

The indicator card of the air pump, Fig. 30, makes the power to overcome the compressive† resistance 1.6 H. P.

Add to this the power to lift the condensing water through, say, half the stroke.....0.4 H. P.
Total power to operate air pump less its friction..2.0 H. P.

The next largest item is the friction of the fly-wheel and its shaft, which weigh about 12,500 lbs. The shaft bearings are 8 ins. in diameter.

Therefore, if the co-efficient of friction is 5 per cent., the power lost by dead weight alone is... 1.95 H. P.

The thrust upon the fly-wheel shaft bearings is practically balanced through the reaction of the cranks, so far as the forces transmitted from one piston to the other are concerned. The remainder,

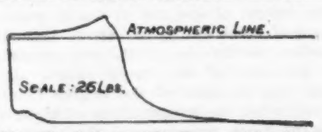


Fig. 30.—Card from Air Pump, Single Acting; 20-inch diameter, 12-inch stroke.

which is that forming the shaded area in Fig. 27, acts to increase the friction of the shaft. The equivalent of this remainder averages 8 lbs. per sq. in. of the high-pressure piston, or 1,500 lbs. This load applied to the shaft bearings with a 5 per cent. friction coefficient makes an additional loss of power of 0.25 H. P.

The mean thrust upon the crank pins and wrist pin at the top of the vibrating levers is equivalent to 16 lbs. per sq. in. on the high-pressure piston, and it is just twice this for the lower pins. The diameter of the pins is 4 ins. The pins on the vibrating levers make about $\frac{1}{3}$ revolution per stroke. The cross head pin has so small a rubbing motion as to make its friction neglectable.

We have therefore for the two crank pins and four lever pins a loss of power of..... 0.46 H. P.
The friction of the pistons and cross heads and vibrating levers is liberally estimated at..... 0.20 "
The valves probably cannot consume over..... 0.33 "

Other parts are practically neglectable. We therefore have the probable loss of power as follows:

Air pump	2.00 H. P.
Fly-wheel shaft	2.20 "
Crank and wrist pins	0.46 "
Pistons, valves, etc., say	0.60 "
	5.26 "

The coefficient of friction of the external bearings may be as high as 10 per cent. The pistons probably will not have as high a coefficient as 5* per cent. The second and third items in the above summary are therefore the only ones that would practically change, and these may therefore be doubled within the limits of friction variations.

This would make the total friction 7.92 H. P. as a possible maximum. It is evident, therefore, that the actual losses of power found by comparison of the steam and water cards do not present any dynamic inconsistency.

RELATIVE DUTY OF ENGINE, WHEN RUN CONTINUOUSLY, COMPARED TO RUNNING DAYS ONLY.

Should the engine be worked days only, so that banking and starting of fires is required every ten or twelve hours, then the reduction of duty should, by my observation of the working of the station at Pawtucket, be about as follows:

To obtain a duty of 124 millions it is necessary that the coal consumption should average 200 lbs. per hour, with 100 lbs. every 6 hours for cleaning fires. Suppose the engine is run 12 hours daily, then at about half an hour after the eleventh hour 200 lbs. of coal is fired, and at the twelfth hour the 100 lbs. of coal which would be used for cleaning, if the engine was not stopped, is used for banking. During the 11 hours that the fires are banked steam falls to about 80 lbs. To raise steam to running pressure requires 300 lbs. of coal, and about 25 minutes after the engine is started 200 lbs. more coal are used. At the end of the first 85 minutes of running 200 lbs. are again fired, and thereafter the same amount is fired per hour.

To run the engine 12 hours, therefore, the consumption is as follows:

Eleven hours of steady firing, 2.000 + 200 for cleaning	2,400 lbs.
Raising steam and first 25 minutes	500 "
Total	2,900 "

If the engine were running continuously, there would have been required for the same 12 hours of work by the engine 12 times 200 lbs. plus 200 lbs. for cleaning, or 2,600 lbs.

The banking and starting therefore requires $\frac{29}{26} = 1.11$ times as much coal as continuous running.

Hence 124 millions duty for continuous running is consistent with $\frac{124}{1.11} = 110{,}000{,}000$ ft. lbs. "duty" for day service.

The reverse of this is, therefore, also true, namely, that if, as appears from the reports of the engine, about 110 millions duty was performed during day running and using banked fires, it is reasonable that about 124 millions should be performed during the continuous running in 1887-88.

[CONCLUDED NEXT WEEK].

Apparatus for Registering Locomotive Oscillations.

Some simple apparatus for automatically recording the riding qualities of locomotives, if more used would undoubtedly result in the correction of many minor defects of running gear; and one such apparatus, unfortunately confined to the registration of vertical oscillations only, was exhibited by the Western Railway of France at the Paris Exposition, and is shown by the accompanying illustrations, for which we are indebted to *Engineering*. The apparatus has been in practical use since 1879.

Fig. 1 shows an elevation of the apparatus, which registers the vertical oscillations of the footplate o a locomotive relative to the leading axle boxes, or, in other words, the vertical play of the spring. A connection to the axle box imparts an oscillatory movement to an arm which is connected by a rod to a carrier sliding on a horizontal bar, this carrier being provided with a marking point which bears upon a thin zinc plate coiled on the drum shown, this plate being coated with a protective varnish which is scratched off by the point. The oscillations of the arm which actuates the marking point also imparts, by means of the ratchet and gear shown, a rotary and also a slow longitudinal movement to the drum carrying the zinc plate. Another marking point *s*, actuated by a rod leading to the footplate, serves to mark by hand on the zinc plate the time of passing each kilometre post.

After their removal from the drum the zinc plates are submitted to the action of acid, when the parts

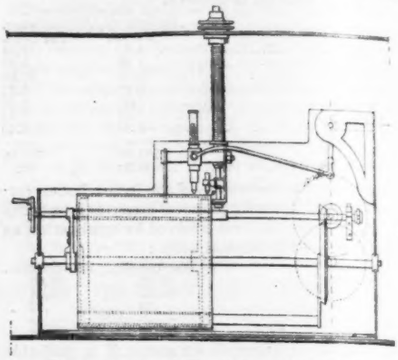


Fig. 1.—Sectional Elevation of Apparatus.

Fig. 2.—Fac-simile of Record Obtained.

Apparatus for Registering Oscillations of Locomotives, Western Ry. of France.

from which the protective varnish has been scratched off are etched away and an engraved plate obtained from which a print can be taken. A fac-simile of a portion of the record obtained by this apparatus is given in Fig. 2, the upper line being a record made by the deflections of the spring, while the lower shows the record of the passing of the kilometre posts.

It will be seen that there is absolutely nothing to indicate the speed in this record, except the amount of the quantity which the apparatus is designed to gauge—the amount of oscillation—but as no great precision in the record of speed is necessary, this is doubtless obtained from independent time records made by the observer at each kilometre, or even merely from the train time-sheet.

Still another apparatus for obtaining the same record is in use on the same road, in which the record is taken off on a flat disk driven by clock-work. This, however, seems to us a less commendable form, and we do not reproduce the illustrations.

A synchronous record of the horizontal oscillations is by all means desirable to complete such a record, and this might be fairly well obtained by nearly as simple apparatus as that illustrated, but which we will not now attempt to outline. We are greatly mistaken if such apparatus would not show, among other useful things, vastly greater steadiness in the American than in the old English type (now rapidly passing out of use) of express locomotive, over the same track at the same speed, and should the present effort to have an American locomotive enter a competitive test in England, be successful, we trust the suggestion will be acted on.

OMAHA BRICK STREET PAVEMENTS are made by setting a course of brick on edge on a 6-in. concrete base. The first $\frac{1}{10}$th of a mile of street so laid cost $2.14 per sq. yd.; a contract now under way is at the rate of $2.03 per sq. yd. The Board of Public Works of that city prefers the concrete base to the double course of brick on sand, as being less liable to yield under heavy wagon loads; it is hence more durable, and unevenness of surface is less frequent.

* See discussion paper 316, Vol. X., Trans. Am. Soc. Mech. Engrs.

† The pump cylinder is vertical, and the indicator was attached to the top of the cylinder.

* Vide Paper on Friction of Packing Rings, Vol. X., Trans. Am. Soc. Mech. Engrs.

The Chicago Union Transfer Ry. Co.

We illustrate herewith the yards which are now under construction in the vicinity of Chicago to facilitate the transfer and exchange of freight and freight cars between the various railways terminating at that city.

It is not often realized what a large proportion terminal charges bear to the total cost of transportation under modern conditions of traffic. The attention of inventors and engineers has been largely concentrated on the problem of reducing the cost of transportation by improvement of the roadbed and rolling stock; and the cost of hauling a ton a mile on our railways of heavy traffic has now been reduced to considerably less than one-half cent. But at the same time comparatively little attention has been paid to expediting and economizing the transfer of freights at terminals, and the expenses of switching, making up trains, distributing cars on sidings, and similar work has grown to be a very serious one.

The simple facts are that at our chief railway centres we have outgrown the systems of transfer which were proper enough in the early days of railroading when traffic was light, and when the proportion of through freight to local was vastly less than it is to-day. The necessities of the case have led to the establishment of belt lines of railway about almost every city of commercial importance, by which cars can be transferred from one railway to another, or through trains can be run without passing through the city at all. In this way the delays and dangers due to grade crossings and numerous switches and frogs are avoided, and the movement of freight is made more rapid and economical.

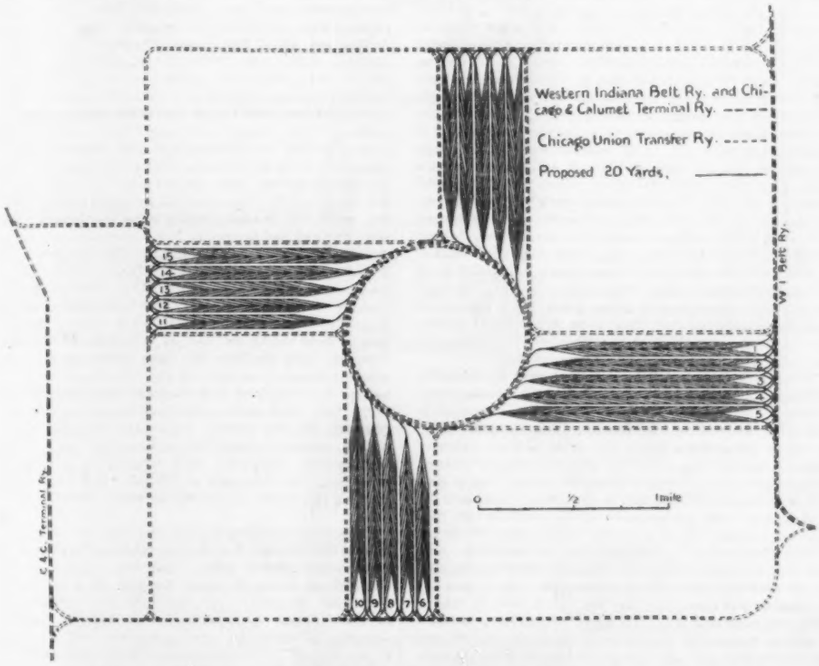
But with the growth of traffic, even the facilities afforded by belt lines may become insufficient This is the case at Chicago, where two belt railways, the Chicago & Calumet Terminal and the Chicago & Western Indiana, are now in operation. In May, 1889, Messrs. J. M. WHITMAN, of the Chicago & Northwestern; J. C. PEASELY, of the Chicago, Burlington & Quincy, and JAS. MCCREA, of the Pennsylvania Co., estimated the amount of business passing through Chicago (not including business for city delivery) at 1,500,000 cars per annum, or over 5,000 cars per day. The cost of handling this business it is impossible to estimate, but it is known to be enormous. The Chicago & Northwestern alone has 87¼ miles of sidings within the city limits of Chicago and has 43 locomotives engaged in switching and transfer work by day and 24 by night, or 67 in all. The delays due to the frequent grade crossings of railways and city streets make the work of transfer exceedingly slow and expensive, and the increased travel on the streets and fast growing traffic to be handled are rapidly making the situation worse.

The above relates only to the cost of transferring cars. Freight passing through Chicago in less than carload lots is largely transferred by teams from one station to another at a cost of teaming alone of 30 to 40 cents per ton, or as much in all as the cost of hauling the freight for 75 to 100 miles on the open road.

The tracks and sidings over which the work of transfer is now carried on are located on land worth from $200 to $5,000 per front foot. Trains pass frequently over crowded streets at grade, and hence must move very slowly; but even then the ordinary street travel is much hindered, and about 175 persons yearly are killed on the grade crossings of the city.

So much for the difficulties and evils of the present system, which it may be said are generally appreciated by the managers of the railways interested. Let us now examine the plan by which it is proposed to obviate in great measure these various evils.

The Chicago Union Transfer Ry. Co. has purchased a block of land of nearly 1,200 acres just west of the city limits and lying between the two belt railways which now tap the various railways terminating in the city. This tract is a nearly level plain lying about 33 ft. above the level of Lake Michigan, with a slope toward the east of a little over 1 ft. per mile. On this tract are to be laid out a system of yards divided into 20 separate divisions, as shown upon the map, one for each of the companies taking part in the enterprise. There will thus be over 1,000 miles of track, giving storage room for 100,000 cars (70 per cent. of the total now owned by the various companies), so it will be seen that the plan provides for future growth of traffic as well as for present needs.



Map of Proposed Yards of the Chicago Union Transfer Railway Co.

These several yards are to connect at their inner end with a circular belt line railway 3 miles in length, and at their outer end with a second belt line about 13 miles in length. As seen by our map, each separate siding may be entered at either end, and the operation of singling out a particular car will be a comparatively easy one.

By the Chicago & Calumet Terminal and the Chicago & Western Indiana Belt Line Ry. the yards will be in communication with all the railways entering Chicago, and independent lines to reach the yards may be constructed as found necessary.

Besides the storage tracks, it is proposed to give each company space enough for the erection of freight houses, engine houses, tool and repair shops, storehouses and warehouses as may be found desirable. The arrangement will also greatly facilitate the establishment of a system of joint inspection for cars. For the transfer of freight in less than carloads a union freight depot will probably be provided, effecting the transportation at the least expense in time and labor.

The projectors of the Chicago Union Transfer Ry. Co. do not claim to have been the first to discover the application of the clearing house principles to the railway business. The credit for this is probably due Mr. J. J. HILL, president of the St. Paul, Minneapolis & Manitoba Ry. Co. As early as 1880 Mr. HILL conceived the idea, which was afterwards put into successful operation at a point half way between St. Paul and Minneapolis, where the Minnesota Transfer yards were established. The business at these cities is much smaller than at Chicago, but, doubtless, the projector at that time little realized the magnitude which the business at Minnesota Transfer would reach in less than ten years. In the year ending June 30, 1889, there was handled at Minnesota Transfer 2,822,048,193 lbs. of freight, at an average cost, including interest on plant, salaries of president, secretary, solicitor, United States customs, superintendent, agents, cashiers, clerks, messengers, yardmasters, car clerks, switchmen, flagmen, sectionmen, engineers, firemen, warehousemen, clerks and laborers, fuel, station supplies, repairs, maintainance, insurance, taxes, personal injury, loss and damage to freight, etc., etc., less than 12½ cents per ton. Of the total 2,822,048,193 lbs. 491,221,048 lbs. was handled through the freight houses, being reloaded.

The financial plan by which this enterprise is to be carried out is quite novel, and seems to be fair to all concerned. The capital stock of the Chicago Union Transfer Ry. Co. is fixed at $2,000,000, divided equally into common and preferred, the latter entitled to cumulative 5 per cent. dividends. The stock will be issued in blocks of $50,000 common and $50,000 preferred to each of the 20 railway companies entering Chicago; and the company will be under the joint management and control of the railways for whose benefit it is projected, all profits from its operation accruing to these various companies.

When the consent of the various companies has been obtained, it is proposed to acquire outright the two belt railways already in operation, if they can be secured at a fair price; if not, such tracks as are necessary to connect the railways with the central transfer yards will be built.

The Chicago Union Transfer Ry. Co. will build on its own property about 25 miles of double track, and a little over 5 miles of four-track railway as shown on the map, which are to be used in common, and will assign to each company ground for a yard to be owned or occupied by it in severalty, on which it may build such tracks, buildings, etc., as in its judgment may suit its requirements. All this being accomplished, such leases or contracts will be made with each individual company as will allow it to run its trains directly to the "clearing-house" yards, and the interest and expenses of the Transfer Co. will be collected from the railway companies on a wheelage basis—thus each company will be able to do this transfer business with the greatest liberty of individual judgment, *at net cost*.

Besides the gain to the railway companies, it is pointed out that the city of Chicago will greatly gain by the reduction in the traffic over its grade crossings and the consequent danger and obstruction of streets. The 400 locomotives which now contribute their fair share to the volume of smoke which hangs over the city will be largely transferred to a point outside the city limits. The merchants and manufacturers will secure much more prompt transfer of their goods than is now possible.

The plan has already been approved by the chief officers of the Pennsylvania, Chicago, Rock Island & Pacific, Chicago & Eastern Illinois, Chicago, Milwaukee & St. Paul, and Chicago, St. Paul & Kansas City railways, and it is believed that such general approval will be secured that the enterprise will be carried through without delay.

"This agitation for a general road law is all unnecessary," remarked the judge. "We have a good one now." "What is it?" asked the major. "Keep to the right."—*Pittsburg Chronicle Telegraph.*

Standard "Overtrack" Stations, Harlem Depression — New York Central & Hudson River R. R.

(WITH INSET.)

By arrangement with the city of New York, the New York Central & Hudson River R. R. Co. is now engaged in removing the grade crossings along the portion of its line in New York City from the Harlem River north to its junction with the New York, New Haven & Hartford R. R., north of Woodlawn station. Fuller details of this work we have given in many past issues. The tracks are being depressed, and when the improvement is completed they will lie in an open cut 16 to 18 ft. below the general level of the adjoining street. The heavy stone retaining wall adopted as a standard for the sides of this cut was illustrated and briefly described in our issue of Nov. 30, 1888.

While this improvement is on the main line of the Harlem Division of the New York Central, there is a considerable and increasing suburban passenger traffic between the terminus at Grand Central Station and the various stations of Mott Haven, Melrose, Morrisania, Fordham, etc. Local trains now make nine stops between Grand Central Station and Mount Vernon, 13 miles, just before reaching which point the New York, New Haven & Hartford R. R. branches off.

The depression of the tracks makes necessary the rebuilding of the stations to suit the changed conditions. The principal point to be observed in designing the new structures was that passengers should be able to reach the station from either the east or west side of the open cut, and should have facilities for reaching the platforms at either side of the tracks, and be protected from the weather in so doing and while waiting there for trains.

The railroad right of way being barely wide enough for the new four-track road-bed, and being bordered on both sides by public avenues (Railroad Ave. east and Railroad Ave. west), there is no land left which the railroad company could acquire on which to build these staions, thence an "overtrack" system is the only alternative left.

The general design, dispositions of the various rooms and mode of construction, is the work of the Chief Engineer, W. KATTE, and the structural iron-work details and architectural features are the work of his chief assistants in those departments, respectively, Mr. G. H THOMSON and Mr. J. D. FOUQUET.

After careful consideration it was determined to adopt the novel standard type for these new stations illustrated this week upon our inset sheet. As seen there, the station spans the four tracks of the open cut, and is hung from heavy riveted steel girders from 5 to 6 ft. in depth, supported on columns resting on the retaining walls at either side of the cut. Thus the entire floor of the building is supported from above, as will be clearly shown in the detail plans, and neither the tracks below nor the floor of the stations is obstructed.

As indicated in the sectional view in the lower left-hand corner of our inset sheet, the station adjoins the bridge by which the street is carried across the depressed tracks, and the entrance to the building is at the centre from the sidewalk of the bridge, and with extra exits at the ends on the side avenues for use on "rush" occasions.

The illustrations given in the present issue show the general design of the completed building. Next week we will give details of the construction of the building, with extracts from the specifications under which the contract for the station at Melrose is soon to be let, and a description of the general arrangement and finish of the structure.

A FOREST PRESERVATION BILL is to be brought before Congress by the American Forestry Association, in accordance with resolutions adopted by the association at its annual meeting in October, 1889. The bill provides that the unsurveyed public lands, embracing natural forests, or which are less valuable for agriculture than for forest purposes, and all public lands returned by the public surveyors as timber lands, shall be withdrawn from survey, sale, entry, or disposal, and that no timber shall be cut or removed from such lands except for the needs of the persons engaged in carrying out the purposes of the act. During such period as the act shall remain in force a portion of the United States military force shall be designated to guard the lands and timber. A United States Forest Commission is to be appointed by the President, consisting of three persons who are experienced in forest matters. The duties of this commission will be to examine the lands and determine what parts should be permanently kept in forest. Nothing in this act is to in any way interfere with reservations of public lands already made, or to be made, by the Secretary of the Interior for the purpose of irrigation, or with any use made of the same for that purpose. There can be no doubt as to the needs of some radical measures in the interest of forest preservation, and this proposed legislation appears to be a step in the right direction.

The Hull, England, Sewage and Pumping Works.

The following matter is taken from data supplied to *The Engineer*, by Mr. A. E. WHITE, Assoc. M. Inst. C. E., and the Borough Engineer of Hull:

The estimated population is 208,000; ratable value, £700,000; and land area, since the extension of the boundary in 1883, 7,901 acres. Previous to the extension the population was 154,000; ratable value, £587,000; and area, 3,621 acres. The entire borough is very flat and low-lying, and the average level of the streets, which are almost without exception somewhat above the natural surface levels, is only about 9 ft. above Ordnance Datum, and, as a rule, the ground nearer the Humber is higher than that farther inland. The subsoil consists of a stiff yellow clay to an average depth of about 6 ft., below which are strata of silt varying more or less in character; also in most places a thin stratum of peat, and often a quantity of running sand. Boulder clay is met with at depths varying from 14 ft. to 35 ft. or more in different parts of the borough. The upper clay forms a good foundation for ordinary buildings, but for structures of a heavier character it is usually necessary to go to the boulder clay. The borough is divided by the river Hull, and a line of docks, into three districts – (1) The Old Town, which was the portion formerly fortified, bounded on the south by the Humber, on the east by the river Hull, and on the north and west by docks, which portion contains a population of about 12,000; (2) the west district, west of the river Hull, and of the line of docks referred to, containing a population of about 152,000; (3) the east district, east of the river Hull, containing a population of about 44,000. The borough is further severed by five large, open agricultural drains flowing to the river Hull or the Humber, from extensive low-lying districts north of the town.

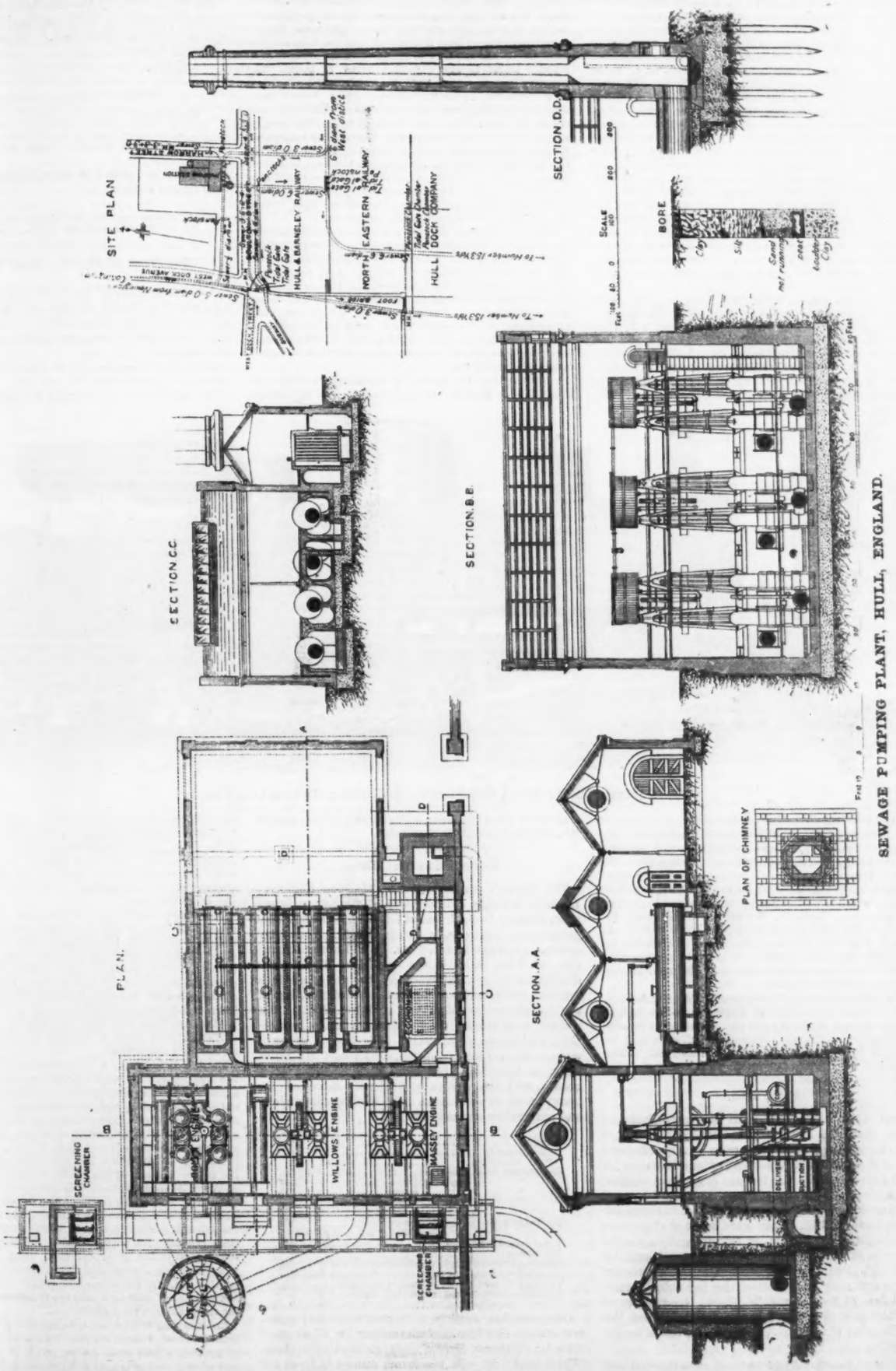
From these facts it will be gathered that considerable difficulties have had to be contended with in the sewerage of Hull. The average level of the streets, as stated, is about 9 ft. above Ordnance Datum, while in the Humber, to which the sewage flows, the level of high water of ordinary spring tides is 12.37 ft. above Ordnance Datum, and the level of low water of ordinary spring tides 10.10 ft. below Ordnance Datum, and under such conditions the inclinations of the main sewers are necessarily very flat, and the outfalls where pumping is not adopted are, of course, closed for a considerable period each tide. As a rule the sewers are at least of sufficient size to enable men to enter for the purpose of brushing them out, where the inclination and flow of sewage are insufficient to render them self-cleansing, and their large size assists in a rapid discharge during the short periods that the outfalls are not tide locked, and also enables the sewers when the outfalls are closed to act as a reservoir, if pumping is not available, or if the quantity of water during excessively heavy rains is more than the pumps for the time being can deal with.

A main sewerage system for the east district was carried out in 1854 and subsequent years, and for the west district in 1863 and subsequent years. Considerable additions have since been made from time to time to such systems. During the past ten years the Corporation have expended the sum of £40,000 upon new sewers, which have been constructed under various contracts, exclusive of sewers included in the works specially mentioned herein, and of works of minor importance executed by the Corporation workmen; and the Corporation are now applying to the Local Government Board for sanction to borrow a sum of £7,950 for the construction of further works of sewerage. The whole of the west district within the old borough boundary is drained to one outfall, excepting a small area which, although connected to the main sewerage system, has also a separate outfall. The main outfall sewer, which discharges into the Humber between the William Wright Dock and St. Andrew's Dock, is 6 ft. 6 in. in diameter for a distance of 1,900 yds., and although laid to an inclination of only 1 in 3,000, it keeps itself clear of any deposit of sewage matter. The area added to the borough on the west side in 1883, which included the Local Board District of Newington and part of the Local Board District of Cottingham, is drained to an outfall 4 ft. in diameter, discharging into the Humber within 33 yds. of the main west district outfall; and since the borough extension a pumping station, hereinafter described, has been established to deal with the sewage of the main west district sewer and the Newington and Cottingham sewer, including the sewage of the portion of the Cottingham district not added to the borough.

The present sewerage system of the east district, with the exception of a short length of sewer, all falls to one point, and discharges into the Humber by an outfall 4 ft. in diameter; a new system of sewers, however, which is usually described as the East District and Stoneferry Drainage, is now in course of construction, and will, when completed and connected to the existing system, not only drain portions of the borough which cannot be drained by gravitation to the present sewers, but will also provide an improved outfall for the entire district. The new outfall will be to the east of the Alexandra dock of the Hull & Barnsley Railway Co., in the face of a river embankment constructed by the company a few years since; and its level will be 10 ft. below Ordnance Datum, or practically the same level as the three existing outfalls already mentioned. The outfall sewer is 6 ft. 6 ins. diameter, with an inclination of 1 in 3,000, for a distance of 700 yds. from the Humber, and almost the whole of such length—being through made ground, or through what was until recently the foreshore of the Humber—is intended to be constructed of cast-iron pipes, supported upon piles, as shown by engraving. The pipes are flanged and jointed in the manner shown by enlarged detail. A strip is cast upon the face of each flange at the outer edge, so that a space of ¾ in. is left between each pair of flanges when bolted together, and such space is caulked from the inside with iron cement. In laying the iron pipes considerable difficulties have been encountered in consequence of the nature of the ground and of the water finding its way into the trench each tide; about half the intended length of pipe has, however, now been successfully laid. The remainder of the sewers, excepting two syphons under agricultural drains, are all of brickwork, varying in size from 6 ft. diameter to 3 ft. 3 ins. by 2 ft. 2 ins., egg-shaped, with inclinations varying from 1 in 3,000 to 1 in 450. The length of sewer from the outfall to the most distant point is four miles, and the total length, including branch sewers, six miles, of which about four miles have now been constructed. The brick sewers, 6 ft. 6 ins. diameter and 6 ft. diameter, are in 14-in. work. Those 5 ft. diameter and the egg-shaped sewers, from 5 ft. 6 ins. by 3 ft. 8 ins., down to 3 ft. 6 ins. by 2 ft. 4 ins., were all intended to have been in 9-in. work, but in constructing some lengths of the larger sizes through bad ground it has been found necessary to use an additional half-brick ring over the invert. The sewers of the smallest size, 3 ft. 3 ins. by 2 ft. 2 in., are in 4½-in. work. Cradling composed of 1-in. deal boards on elm ribs, as shown by sections of 6-ft. brick sewer, has been largely used under some of the deeper sewers; and in the case of these works, as well as in previous works in the borough, such cradling has been found a cheap and efficient means of supporting the brickwork, where the nature of the ground has rendered some support necessary. One tidal gate is provided at the outfall, and a penstock and two further tidal gates 670 yds. from the outfall, where it is intended ultimately to erect a pumping station. Manholes with ventilating gratings are constructed at intervals of 100 yds., and provision for flushing the main sewer will be made near the highest point.

The sewage pumping station provided for the west district of the borough, for dealing with the sewage of the main west district sewer and the Newington and Cottingham sewer, is about 370 yds. from the outfalls into the Humber. At low tide the sewage flows to the Humber by gravitation as before, and when pumping is necessary the sewage is still discharged by one or both of the old outfalls. Two tidal gates and a penstock have been fixed on each of the old sewers, between the points of connection of the sewer leading to the station and the return sewer from the pumps; and while pumping is proceeding, the tidal gates are, of course, closed, and the length of sewer outside them is under pressure, varying with the rise and fall of the tide in the Humber. When the tide is low enough to allow of a discharge by gravitation, the tidal gates are open, permitting the sewage to flow direct to the Humber without passing the pumping station. There are three compound pumping engines of the vertical, inverted, direct-acting type, each capable of discharging 10,000 gallons per minute, or 14,400,000 gallons per twenty-four hours, when working at the maximum speed of twenty revolutions per minute. The cylinders are 18 ins. and 30 ins. diameter respectively, with 4-ft. stroke, and the high-pressure cylinders are fitted with variable expansion gear. Each engine works two double-acting pumps, 30 ins. diameter and 4-ft. stroke, one pump being placed beneath each cylinder. The maximum lift is 20 ft.; but as the pumps have only to work against whatever head of water there may be in the Humber, the lift varies with the state of the tide. A surface condenser is fixed on the delivery pipe from each pair of pumps, so that the whole of the sewage pumped is passed through the condenser. The boilers are of the Cornish type, four in number, each 26 ft. long and 6 ft. diameter, with 3-ft. flue. Steam is supplied at a pressure of 80 lbs., and each boiler is capable of working one engine. A Green economizer, for heating the feed-water is fixed on the line of the flue, between the boilers and the chimney.

The foundations of the pump chamber are carried into the boulder clay to a depth of 32 ft. below the ground level, and formed of cement concrete 6 to 1. The walls of the chamber are of brickwork in cement up to the level of



SEWAGE PUMPING PLANT, HULL, ENGLAND.

the engine house floor, and are supported against the lateral pressure of the earth by a heavy framework of cast-iron girders and struts, fixed at a level about mid-way between the base of the wall and the surface of the ground. The buildings are faced with white stock bricks, with Pateley Bridge stone dressings. A tell-tale, designed by Mr. White, and manufactured by Messrs. W. H. Bailey & Co., Salford, is placed in the engine house. This tell-tale is worked by gearing and spindles from the engines, and by floats and platinum wires from the sump and delivery well, and shows at a glance the level of the sewage in the sump, which is the same as that in the adjoining sewers, the level of the sewage in the delivery well, which practically corresponds with that of the Humber, and also the head against which the pumps are working. The tell-tale further automatically records the above levels on a roll of paper driven by a clock throughout the day, and indicates the time at which each engine is started and stopped, and the number of revolutions worked. To make the instrument more perfect, it is intended to attach to it a rain gauge, which will automatically record not only the daily rainfall, but also the quantity falling within any given time.

The engines, pumps, boilers, etc., were supplied under a contract with Messrs. James Watt & Co., Birmingham, who, together with a number of other firms, submitted their own designs in accordance with a general plan and specification supplied to them. The foundations, buildings, and sewers were executed by Mr. A. W. Stanley, Hull. The cost of the pumping station was as follows: Engines, pumps, boilers, etc., £8,229; foundations, buildings, and sewers, £8,873; other sundry works, £1,243; cost of site, £3,085; total, £21,430. The pumping station was commenced in February, 1883, and formally opened in June, 1884, and has worked very successfully since that time. The average volume of sewage pumped in dry weather is about 7,090 gallons per minute, or at the rate of 10,080,000 gallons per day, which is well within the power of one engine; on rare occasions, however, during excessive rains, the volume is considerably greater than all three engines can properly deal with. As a rule the pumps are worked for eight hours each tide, but during heavy rain the time is extended. The working staff consists of six men, three of whom are on duty each tide.

In a paper which Mr. WHITE read before the Association of Municipal and Sanitary Engineers in June last, he gave the annual working expenses, exclusive of repairs, approximately as follows: Wages of staff, £515; coal, 650 tons best South Yorkshire, at 10s. 2d., £330; oil, stores-water, gas, etc., £130; total, £975.

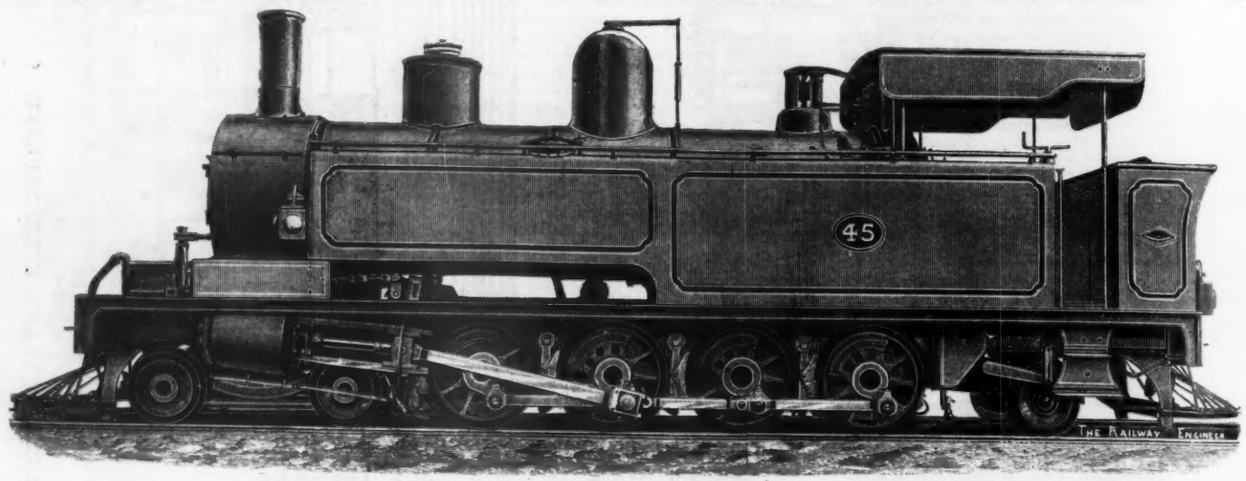
Steel Ties.

Some of the "Standard" steel ties, manufactured by the Standard Metal Tie & Construction Co., of New York, have been in service on a quarter of a mile of the Chicago & Western Indiana Railroad for about four months. The ties are of channel section, with a block of compressed, preserved wood (on end grain) under each rail, as described in ENGINEERING NEWS, June 29, 1889. They were made at the works of Carnegie, Phipps & Co., of Pittsburg, by a special hydraulic press designed by Mr. Aiken and built by the Scaife Foundry & Machine Co., of Pittsburg. The tie company has received the following letter, dated Jan. 23, from Mr. J. W. Clark, Roadmaster of the Chicago & Western Indiana Railroad and the Belt Railway of Chicago. We give the letter nearly verbatim:

Answering your inquiry of 19th inst. as to the condition of the Standard steel ties now in our track on main line north of Seventy-first St., I beg to say that these ties were laid Oct. 1, 1889. They were put in at the above location on south bound track, for the reason that at this point the ballast is very light gravel, which would make the test much more severe than if they had been put in at another location of the road. The traffic on this section is 80 regular trains in one direction every 24 hours. The heaviest engine weighs 96,000 lbs., with 15,000 lbs. on each pair of drivers. So far the ties have given perfect satisfaction, requiring but slight attention, and that only when first laid. There are no loose bolts, clips or nuts, and so far there have been none. It would be impossible for me to estimate correctly at the present time the saving in maintenance, as the ties have not been in service long enough. I believe, however, that there will be a great saving in maintenance, as the only thing to need attention is the bolts and clips, and so far they have shown no indication of weakness in any particular.

There has been no upheaval of the ties where the ground is frozen, and from present indications I hardly believe that such will occur. The ties are in good line and surface, and hold the rails in an upright rigid position, so that the wear on the rail head seems to be more uniform and even than where wooden ties are used. I am free to say that the ties have so far supassed all my expectations. There seems to be no possibility of spreading of the rails. Should a rail break there would be less liability to accident for the reason that the fastenings hold the rail absolutely firm and rigid.

I believe that the saving in maintenance that will eventually be shown, and the absolute safe permanent way which these ties make, to say nothing of their greater life, will show greatly in their favor.



Locomotive for Natal Government Railways; DÜBS & Co., Glasgow.

Locomotive for Natal.

The January number of *The Railway Engineer*, London, contains a description of a heavy tank engine, built by Dübs & Co., of Glasgow, for the Natal government railways, in South Africa. The gauge of these railways is 3 ft. 6 ins. Mr. GEORGE BERKLEY, M. Inst. C. E., is the engineer. The engine illustrates the general tendency towards American types of construction. Its general design is that of the American mastodon type, with the addition of a trailing pony truck. On the whole it has a serviceable, well-set-up appearance. The length of railways in the colony is limited, only about 217 miles being in operation, but they include some steep grades, and the engine is evidently intended for heavy work on short runs. The leading dimensions and particulars are as follows:

	Ft.	Ins.
Gauge		6
Boiler, length	10	6
" diameter	3	11
Copper fire box, length	6	2¼
" " depth at front	4	10
" " back	3	7⅛
" width at top	3	5
" " bottom	2	5¼
179 brass boiler tubes, diameter		1¾
" " length	10	10⅛
Total length of frames	30	3½
Thickness		1
Leading 4-wheel truck, diameter of wheels	2	0¾
Coupled wheels, diameter	3	2
Trailing Bissel truck, diameter of wheels	2	0¾
Cylinders outside (valves on top), diameter	1	5
" stroke	1	9

Ordinary link motion, with rocking shaft; eccentric straps, cast iron. Brake acting on all coupled wheels; Vacuum Brake Co.'s automatic system. Water tanks on side platforms (raised in front for access to valve motion), containing 1,200 galls.; fuel space, 66 cu. ft. Sand is applied to the rails by a jet.

The boiler is fed by two Gresham & Craven No. 8 automatic injectors, with combination clack boxes one of which supplies steam to the brake ejector.

Heating surface—

Fire box	99 sq. ft.
Tubes	888 "
Total	987 sq. ft.
Grate area	15.7 sq. ft.

The estimated tractive force is equal to $\frac{17^2 \times 21}{38}$ = 159 lbs. per pound of mean pressure per square inch on the pistons.

	lbs.
Weight on the 8 coupled driving wheels	69,300
Total weight in working order	100,800

Progress of the St. Clair Tunnel.

A correspondent of the New York *Times* gives an account of the status of work on this tunnel, bringing the record up to a somewhat later date than we have heretofore given, from which we condense the following:

Six hundred men are now at work on the tunnel, advancing at the rate of 15 ft. each day. About 1,162 ft. of the tunnel proper is now ready for trains on the Michigan side, and 844 on the Canadian. The remaining 4,000 ft. will be finished at a rapid rate, considering the nature of the work, if no accident intervenes. It has taken six months to do the work thus far, but workmen are now more accustomed to the task, so that the engineers in charge place the completion of the work not later than the end of the year.

The tunnel itself is over 6,000 ft. long. The approaches are equally long, so that the entire length will be more than two miles. Of this distance 2,310 ft. are under the river, 2,390 ft. on the Michigan land side, and 2,100 on the Canadian. The grade is 2 per cent., except under the river bottom, where it is substantially level. It is an iron cylinder tunnel, the only one of the kind in the country. There is neither brick nor stone used in its construction. Neither are there any stays or supports—simply a mammoth iron tube built in sections underground. It is designed for a single track.

Electric lights make it as light as day; air engines keep the atmosphere as healthy inside as above, and steam pipes hold the temperature at the proper point. The tunnel is perfectly dry, and the disagreeable features common to subaqueous work are entirely absent.

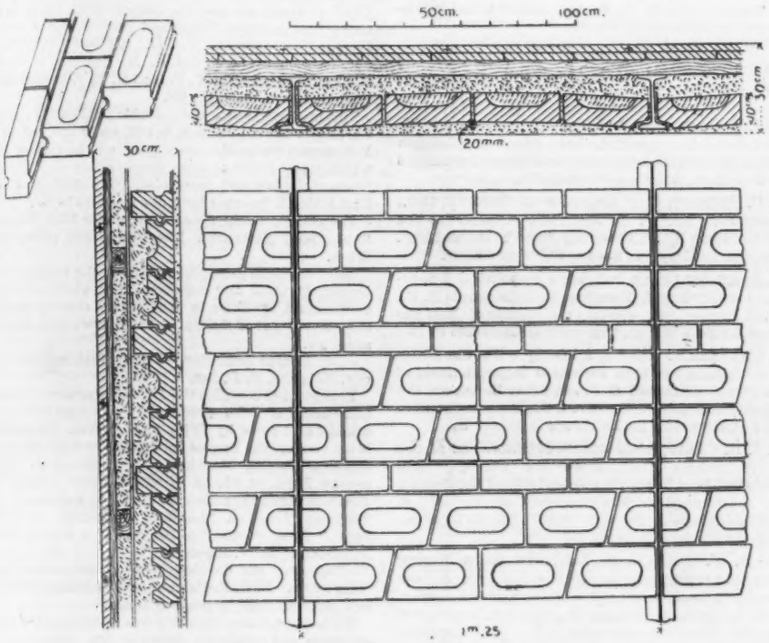
The method of construction is simple. A great cylinder weighing more than 60 tons, 19 ft. 10 ins. in diameter and 16 ft. long, is driven into the blue clay, which constitutes the entire bottom of the river, by the use of hydraulic power, with as much ease as cakes of soap can be carved out of a general mass. Inside this cylinder, which is called a shield, 22 men are at work removing the dirt. As fast as the shield is pushed forward, which is about 2 ft. at a time, the clay thus brought inside the shield is dug out to the edge of the great cylinder. Then the hydraulic jacks are again started, and the immense iron tube moves another 2 ft. into the solid earth ahead of it. Each jack has a power of 3,000 tons, and the combined power behind the shield is more than 400,000 tons.

Another ring of iron lining is put into place, and each foot of tunnel is ready for tracklaying as fast as the work progresses. There is no mason work, as already stated, and when done the tunnel will practically be a continuous iron tube 20 ft. in diameter and nearly 7,000 ft. long.

The iron plates that form the lining are of such curvature and length that any 13 of them, with a small key piece, will make a circle of 20 ft. in diameter. The edges and ends are turned up, each piece being bolted by a dozen large bolts to its neighbor. Each one is 18 ins. wide and weighs about 1,000 lbs. Those for the Michigan side are made in Detroit, and those for the Canadian in Hamilton, and thus the payment of duty is avoided. These great sheets are handled with cranes and so readily that a complete circle is put up in about half an hour. The lining is about 6 ins. thick, so that there is no danger of collapse from pressure.

The ground through which the mineral has passed thus far has been uniformly stiff blue clay. No water has yet been struck, and an occasional pocket of surface gas has been quickly disposed of by turning on a powerful air current. The precaution has been taken, however, to provide by compressed air plant for the contingency of striking a stratum of sand which might lead up to the river and let its waters down upon the subterranean workers.

The cost of the tunnel, of course, cannot yet be stated with any approach to accuracy, but it will be large—much larger than a second similar one would need to be, because so much experience has been acquired during the building of this one that could be at once made available without expense in the construction of another. The material is expensive, but the labor is of the cheapest.



The Schneider Fire-Proof Floor.

The diggers are paid 17½ cts. per hour, the iron men receive 15 cts., and the remainder of the workmen 12½ cts. Aside from the engineering, there is no skilled labor.

Proposed Glasgow and District Subway.

The promoters of the proposed subway in Glasgow (Scotland) and district, have, with the guidance of their engineers, Messrs. SIMPSON & WILSON, brought out an improved scheme, for which they propose to ask powers in the next session of Parliament to construct. The route commences in St. Enoch Square, and includes in its circuit the north and west parts of the city, as well as the most populous parts of the south side of the river, which necessitates it passing twice underneath the river. There are to be two tunnels along the whole course of the line, to be formed of cast-iron segments 1 in. thick. They will be 35 ft. under low water level, or 55 ft. below quay level. The total length of the line will be 6¾ miles, and on the route 15 or 16 stations are to be constructed. At the stations the two tunnels will be joined by an arch rising 11 ft. above the platform, which will be formed between the two lines, and in each case will measure 10 ft. wide and 130 ft. long. The waiting rooms, etc., are to be on the street level, stairs and hydraulic hoists being provided; but as it is arranged that no passenger will require to wait more than two minutes for a train, there will not be much occasion to use the waiting rooms. The trains are to be drawn by the endless wire-rope system, so that a continuous service will be provided, and inconveniences of defective ventilation will be avoided. The method of construction to be adopted is the pneumatic process which has been recently adopted in several important engineering works, and which will allow the whole work to be executed entirely underground, with only one or two shafts for raising the material to the street level—a method which will, of course, greatly increase the expense, but will not interfere with the traffic in the streets. The diameter of each tunnel will be 12 ft., with a clear height of 10 ft. above the level of the rails. The distance between the two tunnels is 6 ft. The level of the top of the arch below the street varies from 21 ft. to 122 ft., while each station will be from 30 ft. to 40 ft below the street level. The line does not interfere with any of the Clyde shipbuilding yards.—*Industries.*

The Schneider Fire-Proof Floor.

MR. EDWARD SCHNEIDER, city architect of Vienna, has invented and thoroughly tested a novel floor, which can be easily understood from the accompanying drawings. He employs the usual iron floor beams, but fills the intervening spaces with a very flat arch of tongued brick. For a span of 6.56 ft., the rise of the arch is only 1.25 ins. Repeated experiments show that that these arches break at the crown before the tongues give way. The Vienna laws require floors to be tested with 400 kilogrammes per square metre, equivalent to 81.925 lbs. per sq. ft. The official reports of the tests show no sinking whatever of the crown under this load. By this method of construction it is claimed that the thickness of floors is considerably reduced. The bricks weigh about 42 lbs. per sq. ft., single layer, and cost in Vienna 14 cts. per sq. ft. They have been largely used, and give very satisfactory results.

The Sioux City & Northern Railroad.

The year of 1889 was one of general stagnation in railway construction in the Northwest. The great corporations, weakened by the heavy expenditures for the extensions of 1887 and by the rate wars of 1888, generally confined themselves to developing the business of the lines already built, or to building only a few short branches to develop local traffic. Independent enterprises were as few in number, and with only a few exceptions were confined to southern Illinois and the lumber regions of Wisconsin. The most important of these independent lines was that built by the Sioux City & Northern R. R. Co. This was, with the exception of the extension of the Burlington & Missouri River R. R. to the Wyoming coal fields, the longest line of railway built in the Northwest during the year, and is of interest as being a local enterprise carried out by local capital. The company was organized in 1887, and early in 1888 preliminary work was commenced. In March, 1888, a 3 per cent. tax was voted by Sioux City, Ia., in aid of the enterprise, and shortly afterward engineers were put into the field and surveys commenced. The surveys were finished, the right of way secured, and most of the preliminary work completed in 1888. Efforts were now made to secure the capital for building the road, but bankers refused to become interested in railway projects in the Northwest and especially in Iowa. Failing to secure outside capital, the company turned its attention to Sioux City capitalists, and the necessary money was obtained. The contract for building the road was let to E. P. Reynolds & Co., of Rock Island, Ill., who transferred their forces from the then completed grade of the Pacific Short Line and commenced work in July, 1889. To supply terminals for the road, the Sioux City Terminal Railroad & Warehouse Co. was organized during the summer. The contractors rapidly pushed the work, and the line was nearly completed by the close of the year. The road is 95 miles long, running from Sioux City, Ia., north through the northwestern portion of Iowa, and crossing the southwestern corner of Minnesota to Garretson, So. Dak. The work was generally light; maximum grade $\frac{4}{10}$ of 1 per cent. and maximum curve 3°. The route is through a good agricultural section hitherto without railway facilities, and it is expected that it will secure a large amount of local traffic. Traffic contracts have been made with the St. Paul, Minneapolis & Manitoba R. R., which will give the road an outlet to the great lakes and the East. The officers of the company are: President, T. P. GERE; Vice-President, JOHN PEIRCE; Secretary and Treasurer, F. C. HILLS; and Chief Engineer, A. K. SHURTLEFF.

The International Dam Across the Rio Grande.

The El Paso *Times* of Jan. 2 devotes a special number to plans and a description of the proposed dam across the Rio Grande River, near El Paso, and the site of the reservoir to be thus formed.

The purpose of this dam is the storage of water for irrigation purposes in Colorado and New Mexico, for use during low water in the river. It is claimed that over one million acres of arid land can thus be rendered productive. Major ANSON MILLS, Tenth Cavalry, U. S. Army, has, by order of Gen. SCHOFIELD, and at the request of the officers in charge of the geological survey of the Rio Grande region, made an extended survey and examination of the region to be improved. From his detailed report the following facts can be gathered:

Work was commenced on the Rio Grande near El Paso on May 4, 1889, and the evaporation noted to the end of September. The total evaporation for 143 days was 46.64 ins., or a mean of about .32 in. per day. As the period used embraced the season of greatest aridity, the probable annual evaporation is put down at 6 ft.

In gauging the flow of the river, the first measurement, taken on May 20, showed 43,000 cu. ft. per second, and the last taken, on July 30, showed 30 cu. ft., and on Aug. 5 the river ceases to flow. The annual average flow is put down at about 1,200 cu. ft. per second. The average quantity of silt found in the water, between June 10 and July 28, varied in 118 samples from one-fourth to one-half of one per cent of the water carried. This is based upon the assumption that 1 cu. ft. of dried sediment weighed 85 lbs. This measurement shows that it would take at least 150 years for the reservoir to fill with sediment.

In seeking a site for the dam, soundings for the bed rock were made through the three miles of the cañon, with octagonal steel rods, to a depth of 52 ft. But two available sites were found, which are described by Mr. W. W. FOLLETT, C. E., in charge of the survey. After describing the characteristics of the two sites, the preference in cost is given to the lower site; but the upper site has the two advantages of being 3¼ miles off, or a sufficient distance from the Santa Fe depot in El Paso to allow that line to be built above the dam on its ruling grade,

and the walls of the cañon allow the dam to be built higher, if required.

The lower site is only 1¼ miles from the depot, and has many advantages. The rock is but 22 ft. from the water surface at the deepest point, and for the greater part of the way across is only from 2 to 9 ft. below the surface; the cost of the dam would only be about half that of one at the upper site, where the rock lies from 30 to 50 ft. deep. But, on the other hand, the Southern Pacific R. R. would have to be rebuilt in heavy work and carried 3 miles through Mexican territory, and the ruling grade would have to be exceeded to get above the reservoir surface.

Estimates then follow, based upon a dam with its crest 60 ft. above the normal river surface; such a dam would form a lake 14½ miles long by 4 miles wide, covering over 26,000 acres, and having an average depth of 23.6 ft. The upper ten feet of this reservoir would irrigate 198,000 acres of land. The design of the dam is a profile derived from the plans recommended by Mr. A. FTELEY, Chief Engineer of the new Croton Aqueduct, for adoption at the Quaker Bridge Dam, and from Mr. WEGEMANN'S Practical Profile No. 2. Sandstone and limestone of good quality are available as materials of construction. The foundations, through an alluvial deposit of 50 ft. at the upper dam, would necessarily be expensive, and a coffer dam, made by freezing the sand on the POETSCH method, is suggested.

The total cost of the improvement is estimated as follows:

Site for reservoir	$60,100
Dam	304,369
Moving Southern Pacific R. R.	204,591
" Santa Fe	385,249
Ten per cent. for incidentals and engineering	96,333
Total estimated cost	$1,059,692

A Curious Escape from Accident.

The Wellsboro, Pa., *Agitator* tells the following curious story of the pleasures of travel on the Fall Brook Co.'s Railroad:

One day last week a woodsman felled a tree on top of the mountain above the railroad track opposite the mouth of Four-mile-run on Pine Creek. The tree did not fall as the man intended, but went toppling over the cliff, and slid down the mountain, gaining in speed at every rod, and trimming itself of branches as it went. A freight train was coming up through the gorge, and the tree crashed endways through a box car loaded with shelled corn, and went on into the creek. There was a hole the size of the log in the roof and side of the car, and the corn was distributed along the track for some distance. When the log struck the car the shock to the train was so violent that a brakeman in a rear car thought it was a collision and jumped off. The car remained on the track, however.

It is not at all surprising that the trainmen behind this log projectile should have had at least, a vague suspicion that something unusual had happened.

Forestry.

The following is taken from a report on the section of Forestry Collections in the United States National Museum, by Mr. B. E. FERNOW, Chief of the Forestry Division, Honorary Curator:

Besides the production of useful material for the arts, there has been more or less distinctly recognized from olden times a certain connection of forest growth with climate, water and soil conditions. Lately, this assumed or observed connection has been subjected to scientific scrutiny, and while in some respects the claimed influences have not yet been quantitatively determined, or, as in the case of the influence on rainfall, even qualitatively defined, yet the most advanced students of the question of forest influences are agreed upon the existence of certain mechanical influences which a forest cover may exercise upon the seasonal flow of water, upon local conditions of atmospheric and soil humidity, upon all local climatic and hygienic conditions which are determined by the atmospheric movements in the lower strata, and upon which the mechanical barrier of a forest belt naturally must bear.

The forest, then, has an interest to man both for the valuable material it furnishes, and for its bearing upon conditions of life, hydrologic, climatic, cultural, hygienic and ethical; this last influence is by no means to be underrated in the life of a nation. In our own country, the recognition of the value of this natural resource, the forest, is only just dawning. We are only just realizing that under the clearing for agricultural land and under the drain for wood and lumber (which now represents an annual product valued at over $1,000,000,000), and under careless destruction by fire and absence of all application of the art of forestry, the natural forests are being decimated at a rapid rate, without regard to future requirements, and without regard to the disturbances which begin to make themselves felt here and there in water flow and upon other conditions, produced by the removal of their protecting cover. The tree-planting on the Western and wind swept plains, scanty indeed when compared with the large area in need of such protection, is almost the only sign of intelligent appreciation of the value of forest growth. A beginning has been made to remedy matters, which, in a country with our institutions, must mainly consist, in the first place, in educating the masses.

PERSONALS.

Mr. J. T. HARAHAN, General Manager of the Chesapeake & Ohio Ry., has resigned.

MR. ARNOLD S. WELCH, of Lowell, Mass., has been elected a member of the Water Board, vice Mr. EDWARD HOLDEN.

Mr. H. T. SHOEMAKER, has been appointed President of the Dayton & Union R. R. Mr. W. M. GREEN is Vice-President.

Mr. TWOMBLEY, Master Mechanic of the Chicago, Rock Island & Pacific R. R., has resigned, and will be succeeded by Mr. GEORGE WILSON.

Mr. W. H. BLISS has been appointed Vice-President of the St. Paul & Duluth R. R. Mr. A. B. PLOUGH is General Manager. Mr. G. T. COPELAND is Superintendent.

Mr. J. E. CHILDS has resigned his position as Assistant General Manager of the Lake Shore & Michigan Southern Ry., and has been appointed General Manager of the New York, Ontario & Western Ry.

Mr. C. SPROATT, City Engineer of Toronto, Ont., has resigned. Mr. W. T. JENNINGS, formerly of the Canadian Pacific Ry., has been appointed to succeed him. Mr. JENNINGS' salary was fixed at $5,000 per annum.

Mr. JOHN SULLIVAN has been appointed Supervisor of the Cincinnati, Hamilton & Indianapolis R. R., vice J. P. Ramsey, who will take the position of Chief Engineer of the Fort Wayne, Cincinnati & Louisville R. R.

Mr. CHARLES E. DOYLE, formerly with the Pittsburg & Western, has been appointed Superintendent of the Peninsula, Richmond & James River Division of the Chesapeake & Ohio Ry., vice Mr. I. G. RAWN, resigned to accept a position with the Baltimore & Ohio R. R.

Mr. J. B. CABLE, Assistant Superintendent of the Iowa & Dakota Division of the Chicago, Milwaukee & St. Paul R. R., has received official notification of his appointment as Superintendent of the Iowa & Minnesota Division of the same road. His division extends from Calmar to Minneapolis.

MR. H. N. SIMS, C. E., for three years Mining Engineer and Land Agent for the Rockhill Iron & Coal Co., Rockhill, Pa., has resigned to accept a similar position with the Shenandoah Furnace Co., with headquarters at Milnes, Pa. He will be succeeded by Mr. A. E. BACHERT, C. E., lately with the Lehigh Valley R.R. at Hazleton.

Mr. W. J. MCNULTY has been appointed Engineer of Surveys for the street department, St. Louis, Mo., vice Mr. CHARLES BROWN, resigned to accept the position of Resident Engineer of the St. Louis & San Francisco Ry., at North Springfield, Mo. Mr. MCNULTY was formerly an engineer on the Missouri Pacific, and later on the St. Louis, Iron Mountain & Southern.

Col. LEONARD J. WRIGHT, about whom we recently made inquiries at the request of a correspondent, died about two years ago at Newtown, Conn., where he was then living. He and his brother, Capt. T. K. G. WRIGHT, were on the completion of the New York & New England R. R. from Waterbury, Conn., to Fishkill-on-Hudson in 1879-82. From then to the time of his death he was engaged in general engineering and contracting work in Connecticut and New York.

Mr. WILLIAM H. TURNER, Superintendent of the New York & New Haven Division of the New York, New Haven & Hartford R. R., died Jan. 31. He was born at Bethlehem, N. H., in 1836. When 17 years of age he entered the office of the Norwalk & Worcester R. R. Co. at Worcester, his older brother being agent for the road at that place. From freight clerk he succeeded his brother as agent, and later became freight agent and afterward superintendent of the Portland & Rochester R. R. After severing his connection with the latter road he became superintendent of the Boston & New York Air Line, which now forms a part of the New York, New Haven & Hartford system. In 1877 he left the Air Line and became general agent of the Norwich & New York Transportation Co. Seven years later he accepted the position of superintendent of the Eastern Division of the New York & New England R. R. Shortly after he was promoted to the general superintendency of the road, and continued in that position until May 1, 1887, when he accepted the position held at the time of his death.

PUBLICATIONS RECEIVED.

—*Tenth Annual Report of the California Board of Railroad Commissioners.* A. ABBOTT, P. J. WHITE, JAS. W. REA, *Commissioners*, 6 x 9 ins., 240 pp. cloth bound. With many tables and excellent map of California.

—*Report on the Internal Commerce of the United States* for the fiscal year 1889. WM. F. SWITZLER, Chief of Bureau of Statistics. Pub. Doc., cloth, pp. 897.

This report is devoted chiefly to the region between the Mississippi and the Rocky Mountains. It contains pretty full statistics about the States and Territories in that region.

—*Builders' Hardware.* A Manual for Architects, Builders, and House Furnishers. By CLARENCE H. BLACKALL, Architect. Boston: Ticknor & Co. 8vo, pp. 322, 504 cuts; good index. $5.

A valuable and finely illustrated publication which we shall hope to notice more fully later.

—*Concessions made by the Supreme Government of Peru to* ALFRED F. SEARS, of Portland, Ore., M. Am. Soc. C. E., M. Peruv. Corps of Eng. and Arch. Pamph. pp. 50.

This pamphlet relates to an important irrigation project for which a literal concession has been granted to Mr. SEARS by the Peruvian Government, which we shall describe more fully later, when the works are further advanced.

—*Analytical and Topical Index to the Reports of the Chief of Engineers,* and the Officers of the Corps of Engineers, U. S. A., upon Works and Surveys for River and Harbor Improvement. Vol. II. 1880-1887. Compiled under direction of Lieut. Col. H. M. ROBERT, U. S. A., by L. Y. SCHERMERHORN, C. E., and H. B. SCHERMERHORN. Pub. Doc., 8vo., cloth, pp. 623.

This most creditable and valuable publication continues the former index published in 1881, up to the end of 1887. It is carried out on the same plan as the former index, which we reviewed at some length when published, and is one of the best and most complete publications of the kind which it has ever been our pleasure to see.

The Duluth Daily News Annual for 1890. Pamphlet, 93 pp., finely illustrated. The Daily News press, Duluth, Minn.

This neat little pamphlet sets forth the rapid growth of Duluth in trade and commerce, and shows a very prosperous state of affairs in that young city. Some of the more important of the statistics given we shall try to find space for.

—*The Stevens Indicator.*—Stevens Institute of Technology, Hoboken, N. J., Jan. 1, 1890.

This number contains the following papers: "Biographical Sketch of John Ericsson," Prof. MacCord; "Transmission of Power by Wire Rope," Wm. Hewitt; "The Most Economical Engine for Small Power," Prof. J. E. Denton; "Testing Machines," G. C. Henning; "An Improved Form of Closed Circuit Burglar Alarm," Prof. Jacobus; "Cable Traction for Elevated Railways," C. W. Thomas; "Note on Rankine's Treatment of Chimney Draft," Prof. Webb; "A Design for a Hot-Air Heating Apparatus," A. W. Burchard.

—*Report of the Commissioner of Education* for the year 1887-8. N. H. R. DAWSON, Commissioner. Pub. Doc., 8vo, cloth, pp. 1209; 90 *pages of index.*

We had concluded that this was an unusually valuable, complete, and creditable report on the educational interests of the whole United States before we turned to the index. When we did so, to our unbounded amazement we found the correctness of our rough rule for estimating the quality of a publication by the completeness of its index confirmed by discovering one of the best indexes, without exception, which we have ever seen in any publication, covering *ninety* pages in small type, double column. In a Pub. Doc. this is especially noteworthy and unusual. We regret that we cannot review this important report as completely as its merit and importance would warrant.

—*Librito del Campo para el Trazado de Curvas,* con Tablas Utiles adaptadas al Listema Métrico para los Estudios y Construccion de Lineas Férreas. Por JUAN MACGEE, Ingo. Civil, Buenos Aires. Pp. 86; all tables.

This is the first field book in Spanish which we have had the pleasure of receiving. It is somewhat coarsely printed, and all the cuts are given by blue prints instead of by engravings; but the tables are very judiciously selected and practical, including a more complete table of the functions of a 1° (metric) curve than as yet exists in English, viz., one giving long chords, apex distances, middle ordinates, and external sectants for angles or varying by 10' up to 180°. The author is Inspector General of the Argentine Railways, and has had an excellent experience in field work, and he promises a later volume of text to accompany this small volume of tables.

TRADE PUBLICATIONS.

—*Illustrated Catalogue of the Vulcan Iron Works Co.,* Toledo, O.; 5¾ x 9 ins., 16 pp.

This firm manufactures boiler fronts and settings, grate bars, arch castings, etc.

—*Illustrated Price List of Carnegie, Phipps & Co.,* Pittsburg, Pa.; 6¾ x 4¼ ins., 81 pp.

This is a neatly got up book of sections, sizes, and prices of beams, channels, angles, light rails and other rolled shapes. Also turnbuckles, rails, plates, etc. Views are given of fireproof floors. One of the interesting features is the Z-column and its adaptation in various forms.

—*Illustrated Catalogue of Thomas Carlin's Sons*, Allegheny, Pa.; 5¼ x 8 ins., 166 pp.

This is a useful catalogue of steam engines and boilers, hoisting and winding engines, pile drivers, shears, derricks, forges, sheaves and blocks, tools, dump cars and tubs, 8 to 25 lb. rails, pumps, pipe, grinding machines, etc. Among the specialties is Carlin's patent safety flue vertical boiler.

—*Price List and Eastern Iron Card.*—Carnegie, Phipps & Co., Limited, Pittsburg, Pa. Pamphlet, pp. 81 chiefly cuts.

A convenient little handbook, combining price list and sizes, drawings of the innumerable different sections rolled, repeated (for the most part) from their well known table book.

—*Guastavero Fire Proof Construction Company.*, 35 Broadway, New York, catalogue and description. Folio, pp. 6, and 15 large plates.

This catalogue of an admirable system of construction, consists largely of plates illustrating the practical application of the system; with a little explanatory text, chiefly reprinted from the description which appeared in this journal Nov. 9, 1889.

—*Motive Power for Street Cars.*—John Stephenson Co., tram-car builders, New York, 5¾ × 7¾ ins., 71 pp.

This is a well-printed and well got up illustrated pamphlet. It contains papers and discussions presented at the last annual meeting of the American Street Railway Association: "The Conditions Necessary to the Financial Success of Electricity as a Motive Power," "Street Railway Motors other than Animal, Cable and Electric." Also papers on "Cable Railways in Australia" and "Electric Traction by Storage Batteries." While there is no direct advertising of the John Stephenson Co., whose cars are in use in all parts of the world, this interesting pamphlet will be a good advertisement for the firm, as it will certainly be read and kept for reference by street railway men and others interested in the traction problem.

—*The Saegmuller Solar Attachment.*—How to adjust and use it; with solar ephemeris and refraction tables. Fauth & Co., manufacturers of engineering and astronomical instruments, Washington, D. C.

Describes and illustrates an attachment to a regular engineer's transit by means of which the astronomical meridian can be obtained in a few minutes with an accuracy sufficient for all general uses. The pamphlet gives full illustrations of the attachment, its adjustment, tables for use, and the price. It can be obtained on application to the address given.

SOCIETY PROCEEDINGS.

Engineer's Club of Cincinnati.—At the regular meeting on Jan. 16, Mr. L. W. Mathewson read a paper on "Street Construction," which included a description of the construction of and material used in, various kinds of street pavements.

Denver Society of Civil Engineers and Architects.—At the meeting on Jan. 28, Mr. R. A. Wilson read a paper on the necessity of a good triangulation survey and topographical map of the State. The following officers were elected for the current year: President, Geo. G. Anderson; Vice-Presidents, H. L. Aulls, E. P. Martin; Secretary and Treasurer, Geo. H. Angell; Executive Committee, P. H. Van Diest, R. D. Hobart, F. E. Edbroke. A committee was appointed to consider all matters pertaining to a national association or amalgamation with other societies, C. S. Thompson, R. D. Hobart, J. S. Titcomb, P. H. Van Diest and Geo. H. Angell.

Liverpool Engineering Society.—At the meeting of this English society on Jan. 15, Mr. M. C. Bannister read a paper on "Mechanical Refrigeration and the Manufacture of Ice."

Having pointed out that artificially produced cold had now become an absolute necessity, not only for the maintenance of our food supplies, but also for the economical prosecution of many chemical processes, the author gave a brief summary of the laws regulating the transmission of heat or cold from one medium to another. He then reviewed the various chemical and mechanical methods which have been used for the artificial production of cold, after which he proceeded to treat thermo-dynamically the various systems of refrigeration now in use, namely, those known as the cold air, sulphuric ether, sulphurous anhydride, carbonic anhydride, ammonia compression and ammonia absorption. Each of these systems he dealt with separately, resolving all to a common thermal basis, viz; the heat units in one pound of coal consumed to raise steam to be used in a fairly high class modern steam engine. The general results obtained were demonstrated by graphic thermal diagrams showing the various losses and ultimate useful effect of each system, and tables giving the vapor tensions and the latent heat units of various temperatures. The author then briefly sketched the mechanical details of ice manufacture explaining his own recent improvements for the more economical manufacture of crystal ice in large blocks.

Engineer's Club of Philadelphia.—Record of regular meeting, Jan. 18, 1890. President H. W. Spangler in the chair; 12 members and 2 visitors present. The Secretary presented, for Mr. Charles S. Churchill, an illustrated paper on the Economical Form and Construction of Arches in Railroad Embankments. In his letter transmitting his paper the author says:

"The data upon which this paper is based, the general facts and the plans referred to, were collected and prepared three years ago. My investigations of this subject started with a query of mine as to how much of an increase should be given to the thickness of the key of a deeply buried arch over that of an arch located in a low bank. I made some very careful experiments as to the actual pressure of a pile of earth upon a small buried object representing an arch. Notwithstanding that a number of engineers have from time to time claimed that the actual pressure on such a body is that of a wedge-shaped mass, whose base is the width of the body receiving the pressure, I found, nevertheless, that the actual pressure in loose material was the weight of a prism of earth, the base of which was the area of the body and the height that of the bank.

"Proceeding with this investigation to determine the proper thickness of keys for different spans under banks of various heights, I found that the full centre arch is not the most economical form for a buried arch, as noted in this paper, and the true form was then determined.

"The proper form of arch bridges of larger spans and under light banks was next taken up; and as pressure of business interfered with the completion of this part of the subject, I have always considered my work unfinished.

"In regard to the so-called false skew arch, I have only to refer inquirers to a number of good examples on the Pennsylvania Schuylkill Valley R. R. north of Hamburg, spans being from 12 ft. to 55 ft., end skew to barrel of arch from 50° to 80°.

"As to the cost of arch masonry, I have only to state that some of these arches were not undertaken until I was able to furnish proof that a first-class iron girder would not be materially cheaper."

HOWARD MURPHY, *Secretary and Treasurer.*

American Society of Civil Engineers.—The regular meeting was held Feb. 5, President W. P. SHINN in the chair.

The Secretary announced the deaths of the following members: O. E. Cushing, of Lowell, Mass.; B. H Greene, of Helena, Mont.; Samuel Keefer, of Brockville, Ont.; W. H. Wightman, of Ashland, Ore. Mr. V. L. Clement, of Idaho, has been elected a Fellow of the Society.

Mr. COPE WHITEHOUSE read an interesting paper upon "The Raijan Canal and Storage Reservoir, Egypt." It has been discovered by Mr. Whitehouse and other explorers that the Pharoahs had made a storage reservoir in the desert, to the southwest of Cairo, and it is proposed to construct a canal (partly in rock tunnel) to turn the water of the Nile into the Raijan basin to re-establish this ancient reservoir or lake. The cost is estimated at between $7,000,000 and $10,000,000. The reservoir would cover about 250 sq. miles and have a depth of about 250 ft. Lines of levels have been run with great care by the direction of the Egyptian Government. This work has been done by officers of the Royal Engineers (of the English army) who have been in the Indian irrigation service. This project has already been described in ENGINEERING NEWS, Nov. 9, 1889. The paper was illustrated by the stereopticon; maps and photographic views being shown. A vote of thanks was tendered Mr. Whitehouse.

The following candidates were elected:

MEMBERS.

Oscar E. Balston, Chief Engineer, Kings County Elevated R. R., Brooklyn, N. Y.

Geo. C. Dickinson, Assistant Engineer, Hudson Suspension Bridge & New England R. R., Fort Montgomery, N. Y.

Joseph Hobson, Chief Engineer, Great Western Ry., and St. Clair Tunnel Co., Hamilton, Ont.

John A. McDonald, Engineer of Bridges, Bridge and Road Dept., Sydney, New South Wales.

Maurice S. Parker, Chief Engineer, Sioux Falls, De Smet & Northern Ry., Winona, Minn.

Edward C. Shankland, Engineer to G. W. G. Ferris & Co., Pittsburg, Pa.

Wm. H. Warren, Consulting Engineer to the City Council, Sydney, New South Wales.

Geo. L. Wilson, 1st Assistant City Engineer, St. Paul, Minn.

JUNIORS.

Edward H. Connor, Union Bridge Co., Buffalo, N. Y.

A. P. Folwell, New York State Canals, Glens Falls, N. Y.

E. E. de Lancey, New Croton Aqueduct, Sing Sing, N. Y.

H. S. Speidel, Riverside Bridge & Iron Works, Paterson, N. J.

J. F. Temple, Edge Moor Bridge Works, Edge Moor, Del.

H. G. Tyrrell, Pencoyd Bridge Co., Pencoyd, Pa.

T. T. Watson, Morristown, N. J.

Illinois Society of Engineers and Surveyors.—The annual meeting was held in Peoria, Jan. 29-30. Owing to the prevailing influenza the attendance was unusually small.

The principal papers were as follows: President's Address; "The Engineer and His Work," C. G. Elliott, Gilman; "The New Water Works of Peoria," W. C. Hawley, Resident Engineer; "Iron Substructures for Highway Bridges," J. H. Burnham, Bloomington, which was historical, and related chiefly to the difficulties encountered. The writer described the failure of some pile foundations, owing to the decay of the piles inclosed in the concrete. One of the most valuable papers of the meeting was "Sharp Curves," by Edwin A. Hill, of the C., C., C. & I. R. R., Cincinnati, O. The paper referred to the use of sharp curves in yards and station grounds, and explained some of the conditions which might make the use of the minimum curvature desirable. The writer first deduced the mathematical relation between radius of curve, width of car, elevation of rail, distance between head-blocks, etc.; and then gave an account of numerous sharp curves in yards and of the difficulties encountered in operating them. "Notes on the Use of Cement Mortar," Prof. I. O. Baker, Champaign, was an argument for the use of cement instead of lime and explained the conditions which determined whether Portland or Rosendale cement should be used. "Alterations in the Washington Street Tunnel," S. C. Colton, Chicago, was an interesting paper fully illustrated by large scale drawings. "Interlocking Switches," Charles Hansel, Consulting Engineer of the Illinois Railroad Commission, Springfield, described the various systems, and presented statistics of the growth of interlocking in the United States and particularly in Illinois.

The other papers read were as follows:

"Drainage," Rudolph Bourland, Peoria; "Engineering Features of the Operating Department of Railroads," E. L. Morse, Cazenovia; "The Elimination of Local Attraction in Mine Surveying," D. H. Davison, Minonk; "Topographical Surveying for Drainage Purposes," D. J. Stanford, Chatsworth; "The House for Health," S. A. Bullard, Springfield; "The Completion of the Cairo Bridge and the Terminal Facilities at Mounds," S. F. Balcom, Assistant Engineer, I. C. R. R., Champaign; "How to Find a True Meridian," D. H. Davison, Minonk.

The following papers, in the absence of their authors, were read by title and passed for publication:

"Public Roads," J. L. Clark, Monience; "A Change of Line on the C. & A. R. R.," E. Philbrick, Assistant Engineer, Chicago; "Prevention of Abrasion of Creek and River Banks," E. J. Chamberlain, Engineer Say Island Levee, Pittsfield; "Masonry Structures for Railroads," T. A. Allen, Chief Engineer, P., D. & E. R. R., Terre Haute Ind.

A very interesting part of the meeting was the discussion of the following topics:

No. 1.—What is the cost of repairs of railway pile bridges? Also their average life before renewal? What is the number of feet of pile bridge per mile on your road?

No. 2.—What do you consider the proper super-elevation of rails on curves, on main line and in yards?

No. 3.—What is the average length of life of ties on your road? At what cost will preserving treatment be economical?

No. 4.—What jurisdiction should the State exercise over railways in reference to the prevention of accidents?

No. 5.—How much can be expended per mile in the construction of roads in the rural district, and yet yield a good rate of interest to the community using the road?

No. 6.—What comparison is there in efficiency and in cost in your vicinity between the two methods of maintaining country highways,—"working out" the tax, and that of tax in cash and trained labor? Give statistics.

No. 7.—What is the best method of perpetuating corners which fall in graded roads?

No. 8.—What are the functions of surveyors in reference to plats and re-subdivisions of city lots as given by Chapter 109 and by Paragraphs 62 and 63 of Chapter 120 of Revised Statutes?

No. 9.—In letting contracts should the lowest bid always be accepted, and if not what other feature should influence award of contract?

No. 10.—What is the ratio of municipal engineering expenses to the cost of work designed and supervised?

No. 11.—How far should legislative bodies decide details of engineering questions?

No. 12.—What rule for distributing tax should be followed in special assessments?

The officers for the ensuing year are as follows: President, Prof. A. N. Talbot, Champaign; Vice-President, D. L. Brancher, Lincoln; Executive Secretary and Treasurer, S. A. Bullard, Springfield; Recording Secretary, S. F. Balcom, Champaign.

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GEO. H. FROST . . . . . BUSINESS MANAGER

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Advertising rates. 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we will be obliged if parties who fail to receive their papers promptly will notify us without delay.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Civil Engineers' Club, Cleveland, O.—Next meeting, Feb. 11. Secy., C. O. Palmer, 22 Cedar Ave.

New England Railroad Club, Boston, Mass.—Next meeting, Feb. 12. "M. C. B. Association Form of Contract for Chilled Wheels," Rooms in the United States Hotel.

Civil Engineers' Association of Kansas, Wichita, Kan.—Next meeting, Feb. 12. "English Engineering," O. Mulvey; "The Problem of Railway Terminals in Wichita," R. W. Luttrell. Secy., J. C. Herring, Wichita.

Engineers' Club of Philadelphia, Pa.—Next meeting, Feb. 15. Secy., Howard Murphy, 1122 Girard St.

Western Railway Club, Chicago, Ill.—Next meeting, Feb. 18. Rooms in the Phœnix Building. Secy., W. D. Crosman.

Engineers' Society of Western Pennsylvania.—Next meeting, Feb. 18. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—Next meeting, Feb. 18. Secy., S. E. Tinkham, City Hall.

Engineers' Club of St. Louis, Mo.—Next meeting, Feb. 18. Secy., W. H. Bryan, 46 Laclede Building.

American Society of Civil Engineers, New York.—Next meeting, Feb. 19. Secy., John Bogart, 127 E. 23d St.

New York Railway Club.—Next meeting, Feb. 20. Rooms at 113 Liberty St.

Civil Engineering Society (Mass. Inst. of Technology), Boston, Mass.—Next meeting, Feb. 20. Secy., Clement March.

Engineers' Club of Kansas City, Mo.—Next meeting, March 3. Secy., Kenneth Allen, 200 Baird Building.

Civil Engineers' Society, St. Paul, Minn.—Next meeting, March 3. Secy., Geo. L. Wilson, City Hall.

Western Society of Engineers, Chicago, Ill.—Next meeting, March 5. Secy., J. W. Weston, 230 La Salle St.

THE quotation given in our issue of Feb. 1 from Mr. COLEMAN'S excellent address on Civil Cleanliness should have been credited to the *Sanitarium*, by which journal alone the address was published in full. Should any of our readers desire to obtain the full address, they can do so by addressing A. N. BELL, M. D., Editor, at 113 Second Place, Brooklyn.

WE shall next week give some considerable further correspondence in relation to the great question of whether or not it is true that current experience is causing regret that the M. C. B. standard was adopted among some of those who formerly favored it, but have since become convinced of the error of their ways. If there be a single person of any prominence who has taken an interest in this question and has since changed his views, we have not been able to find or hear of such a person, and we do not believe there are any such. On the contrary, we have postponed the presentation of the letters referred to in order to give with them some positive evidence of a very interesting character, which shows better than any words can do that it is most unlikely that there is any such person, by showing that he can have had no grounds for forming such opinion unless he has been singularly negligent in ascertaining the facts of experience. These facts are what railway officials are now most anxious to learn, and we think we may fairly say that we shall be able next week to give them a far larger aggregate of the cold facts in the case than has ever before been accessible, or indeed, than has ever existed, until within the last week or two. In connection with the map which appeared in our issue of Dec. 21, 1889, showing what has actually been accomplished to date, this evidence of what the effect has been in repairs seems to us to make a pretty clear case; such as will leave that railway official in a pretty poor position who persists in maintaining an attitude of indifference or hostility to this great and humane reform.

A TABULATION in the office of the New York State Railroad Commission shows that there are 35,423 freight cars equipped with automatic couplers, out of 180,873 such cars in use on the different railroads wholly or partly within this State. These automatic couplers were brought into use under the law of 1884, which provided for the putting of such couplers on all the new cars built or old ones repaired. In accordance with the automatic car-coupling law of last year, all freight cars used in the State will have to be so equipped by Jan. 1, 1892.

The greater portion of the stated 35,423 cars are equipped with link couplers only, the couplers of the M. C. B. standard type reported to us in connection with our map of Dec. 21, 1889, being only 18,597, distributed as follows:

N. Y. Central & Hudson R.	8,000
Erie	3,745
N. Y., Ontario & Western	50
Rome, Watertown & Ogdensburg	400
West Shore	400
Total of lines wholly within the State	12,595
Eight other companies partly within the State	6,002
	18,597

Considering that the law did not require reconstruction of old rolling stock until 1892, and permitted, not to say encouraged, a wide range of choice between couplers, so that there was danger of our last state being worse than the first, it must be admitted that the introduction of automatic couplers has made rapid progress in the State. In the present state of the coupler problem the addition of more link couplers of any kind does not really benefit the public or railway employés, and it should now be prohibited; although few more are likely to be put on, whether legally prohibited or not. It does not follow that the law was originally a mistake, or has done harm. It has doubtless led certain companies into expenses which will prove unprofitable; but the loss even of these companies will not be great, and prior legislative action was an important element in hastening a decision by the M. C. B. Association, which was naturally indisposed to act hastily, and might not have acted at all to-day except that these State laws, and the beginning of outside action by a "syndicate" of railways under WM. P. SHINN, showed that the association must act speedily if at all. It naturally concluded to act speedily.

As we have often before noted, while the day of small canals seems to be nearly over, the era of great ship canals seems to be just opening. Several such canals of great importance are likely to be constructed before 1900.

A measure of more than usual apparent merit for a new ship canal has been introduced in Congress this week for the survey of a route for a "sea-level" ship canal to connect Lakes Superior and Michigan direct across the upper peninsula of Michigan, from Little Bay de Noquet, on which Escanaba is situated, across to Au Train, on Lake Superior, the total distance being some 30 miles, and saving nearly 200 miles of lake navigation. For any moderate traffic the saving might hardly pay for the cost of the canal, but the traffic between the two lakes in ore alone is very large, besides which there is a large and increasing traffic in building stones, of which Lake Superior has an unequaled variety. The valley of the Whitefish River, which heads within a few miles of Lake Superior, close to another small stream which empties into the latter, furnishes the route which is said to be throughout a flat and even country. Of the great question of the height of summit we are not advised, but if this be only moderate, the project may well be one deserving of early construction. Lake Superior being about 10 ft. above Lake Michigan, its level could be maintained until near Lake Michigan, reducing the quantity of excavation; and the increasing ratio at which the traffic of the Sault Ste. Marie is increasing, gives plain indication that there would be ample use for such a canal if constructed so as to admit vessels of the same draught as the Sault. It is reported that private parties are prepared to construct the canal if the government will give them the right to collect tolls. The latter, however, we venture to doubt. It is quite certain that the tolls would not be permitted to remain on long, with the example of a free government canal at the Sault.

SOME of our English friends, through the Engineering Committee of the Edinburgh International Exhibition of 1890, have been sending out invitations to seven of our locomotive works to send over "a representative American express engine for exhibition and practical trial," it being stipulated that the engines should be worked throughout by American engineers, "with fair play in every respect guaranteed." This invitation having met with "no very enthusiastic response," as *The Engineer* remarks, in fact having been declined on the ground that the expense would exceed the probable benefits received even from victory in the trial, various of the English journals gently imply that it is only another case of "letting I dare not wait upon I would." *The Engineer*, with its ever charming, ever new capacity for blundering about things American, further remarks:

> "We are accustomed to consider that our locomotives can run faster, keep out of the repairing shop longer, burn less coal, cost less to construct and maintain, and generally look neater and more business-like than the creations of the Transatlantic brain. America on the other hand, holds that the only country in which locomotives are built and run properly lies *under the shadow of the stars and bars*"

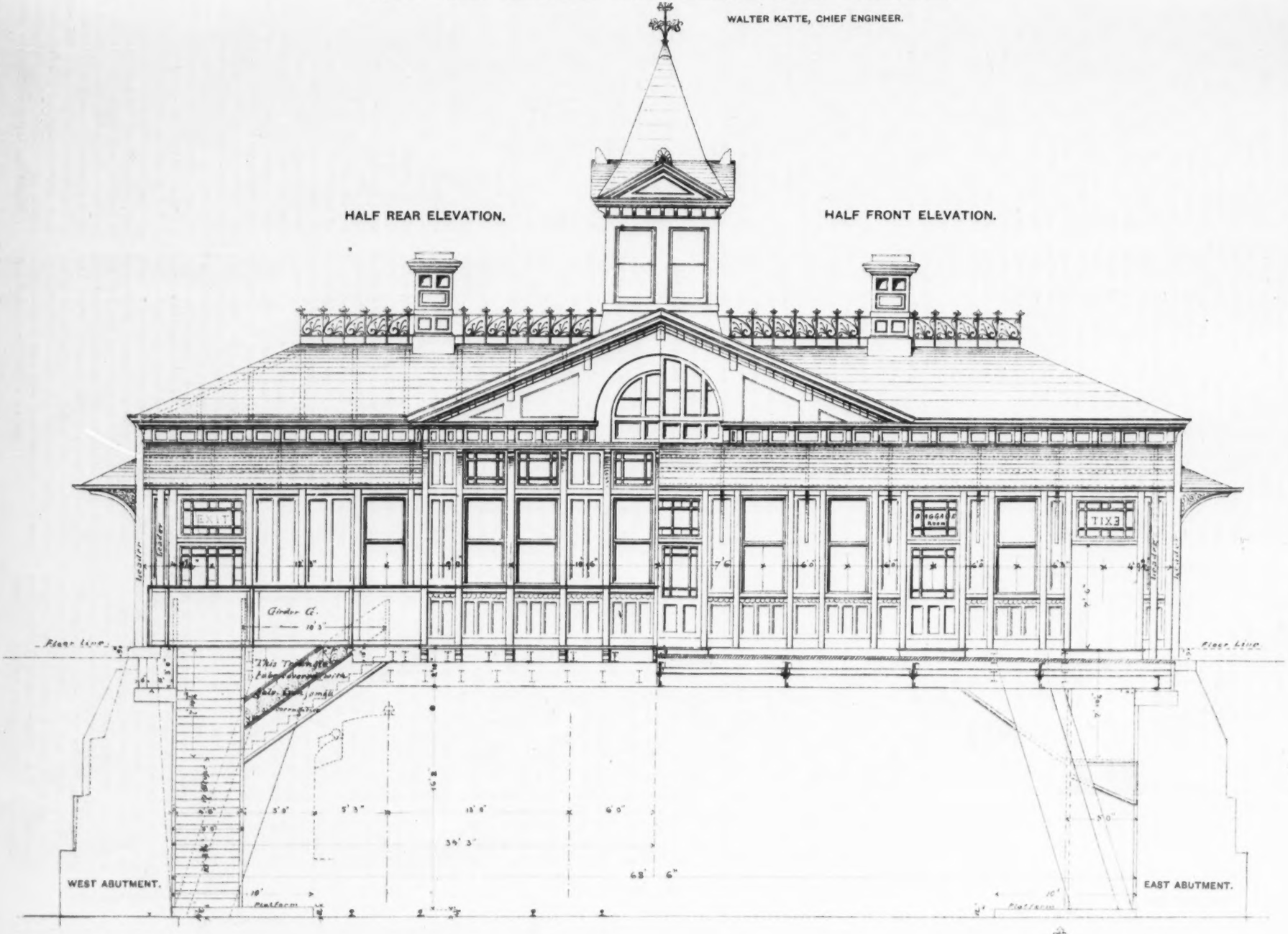
The editor of *The Engineer* cannot be still voting for Gen. JACKSON for President, because he probably never heard of him; but he evidently has not heard either of the result of our late unpleasantness, and labors under the impression that the other side won. It will, therefore, be news to him to hear that the Stars and Stripes now float over this country, *nem. con.*, the "stars and bars" being laid away in innocuous desuetude; and we venture to add further, that every locomotive which floats that flag can ignominiously whip any and every locomotive which carries at its mast-head the golden harp of England's banner.

STANDARD STATION, HARLEM DEPRESSION,
NEW YORK CENTRAL AND HUDSON RIVER RAILROAD.

WALTER KATTE, CHIEF ENGINEER.

HALF REAR ELEVATION.

HALF FRONT ELEVATION.



CROSS SECTION THROUGH

CROSS SECTION THROUGH

WEST ABUTMENT.

EAST ABUTMENT.

CROSS SECTION THROUGH
WAITING ROOM AND VESTIBULE.

Detail of Column in Waiting Room.

Horizontal Section.

CROSS SECTION THROUGH
STAIRWAY AND EXIT.

BASE OF RAIL

BASE OF RAIL

CHAS. HART & SONS, LITH. 40 VESEY ST. N.Y.

WITH so bad a memory for the result of our late family controversy it is less remarkable that *The Engineer* should have forgotten that several prolonged battles of "English *vs.* American locomotives" were fought out years ago in Canada and in Mexico, and in South America and elsewhere, not all of them by any means on poor track; some on very good track; and with Englishmen managing both sides of the controversy; and that as a result there is absolutely no interest in this country over the question of "English *vs.* American Locomotives," which causes such heated controversy in the English engineering journals. We may add, that in England itself there has been a long-drawn-out battle under purely English auspices, with the result that a good majority of the new English locomotives are of the American type in certain prominent features. If there be anything in which English locomotives can make a good showing, it is in the ability to haul light trains at high speed over the most costly and perfect track, with moderate consumption of coal. We are not overwhelmingly patriotic, and we do not entertain any great doubt that in this particular kind of service, which is with us a rather unimportant sub-variety, no locomotive which we could send over would do any better than the locomotives it would meet there. It might even not do quite as well. But when it came to hauling very heavy trains, especially maximum trains, at slower speeds, or to coal consumption per ton mile or passenger mile (units which our English friends do not have to compare their work by, most unfortunately for them), or to cost of repairs for equal loads, or long mileage per year and between repairs, or to service on slightly inferior track—here, we think, the English locomotive would compare to poor advantage.

CITIZENS of Philadelphia are very properly exercised over the present effort of the semi-defunct Schuylkill Canal Co. to dispose of its water rights and privileges at a round sum to the city of Philadelphia. From considerable personal knowledge of the canal and the country traversed, it can be said here that its selection as a source and conveyor of "pure water" to Philadelphia surprises other people than the residents of that city. This so-called canal is in great part the Schuykill River itself, flowing through a thickly populated district and polluted by all manner of incidental filth. Where it is a canal it is in the main fed by the river, and we fear it would take exceedingly minute analysis to detect the difference in the water so supplied and that flowing over the Fairmount dam at the present pumping works. It even now seems that the water privileges claimed by the canal company are of little avail, or are already appropriated as a source of water supply by other towns in the Schuylkill valley. But even were there sources available miles up the river, the best water in the world would be contaminated by passing down the river and canal as a conduit. No artificial, properly closed conduit seems to be contemplated, nor could such be economically built; but if Philadelphia really wants an unlimited supply of pure water from a region that neither agriculture nor settlement is likely to contaminate, let them go to the Delaware Water Gap at once. Any relief such as that promised by the promoters of the Schuylkill scheme is only temporary, and of most doubtful purity at the best; but the money it would cost would be a permanent loss, in fact, a willful waste, when the time comes, as it must, to look in another direction for the future supply. The Water Gap scheme would cost millions, of course; but the city to be benefited is the second in population and manufacturing importance in the United States, and it is worth all it would cost to obtain at once a sufficient quantity of water from a source of undoubted purity, and to stop trifling with the health of a million people meanwhile.

WE greatly rejoice to learn that the brave and —in our judgment—hopeful attempt to utilize the Grand Cañon of the Colorado as a railway route has not resulted in the sad loss of life so vaguely reported last week. Instead of this, the plucky little party of seven under ROBT. B. STANTON, Chief Engineer, is, so far as heard from, alive and well, with the exception of one member, Mr. F. A. NIMS, photographer, who injured his foot somewhat and was accordingly sent back out of the cañon by Mr. STANTON before proceeding further downward. Out of this incident appears to have arisen the rumor that "a fourth of the party" were lost, which was finally put onto the wires and spread about the country. Mr. NIMS will be a loss to the party, as he was an excellent photographer who has served in both expeditions, but his injury is not serious, and his loss not irreparable. Chief Engineer STANTON'S letter to his wife, moreover, written some two weeks ago, states that all members of the party were well, and that "the worst part of the cañon was past"; the last a somewhat doubtful matter. Whatever the result of this survey, it is eminently proper that further explorations of the cañon should be made; and it is entirely probable that as the cañon is descended and the river becomes larger, although the cañon may become deeper and grander, it will also become wider and with more of a footing to it. It has already become evident that Major POWELL'S original exploration and report, creditable as it was to him, gives a radically imperfect idea of the character of the cañon from an engineering point of view. No words may be strong enough to express the awful grandeur of a cañon 6,000 ft. deep taken as a whole, and yet the lowest 200 ft. may break off into a comparatively easy slope, and usually does through the greater part of any long cañon.

National Regulation of Railway Safety Appliances.

The annual report of the Interstate Commerce Commission, which we reviewed and briefly discussed in our issue of Jan. 11, has called general attention to the subject of railway safety appliances, and to the proposal that their adoption shall be made compulsory by national legislation. Let us briefly consider what are the valid reasons why the national government should interfere in this matter.

There are still, we believe, a very few persons who hold the theory that it is nobody's business whether a railway carries on its traffic carefully or carelessly as regards the safety of its passengers and employés. It is generally acknowledged at present, however, that a railway company is under obligation to operate its road as a common carrier, giving reasonably safe and comfortable facilities to its patrons, and providing reasonably safe machines and methods for its employés' use. If it does not do this, and passengers suffer injury or inconvenience, or employés receive injury, through the corporation's negligence, they can recover damages in a suit at law. But even this, it is now generally recognized, does not sufficiently protect the rights of the public. Suppose the manager of a railway reasons that most of the passengers over his road will patronize it just the same whether any especial attention is paid to safety or not. He is sure of saving many thousand dollars a year perhaps by cutting down his track hands, his brakemen and his inspecting force, and using a cheaper grade of materials and supplies throughout. While he certainly increases the risks by these measures, the road may very likely go through several years with less accidents and less damages to pay than a road which has been fairly progressive in adopting safety appliances; for while the mathemetical chances are against it, yet only when taken within wide limits of time and area can we be certain that disaster will follow neglect.

Now, has this manager a right to put thus in jeopardy the lives and limbs of his passengers and employés? Should not the State provide some agency to see that common carriers observe such reasonable precautions and adopt such safe methods as suit their traffic and their finances, and that they do not speculate with the lives in their charge by over-economy in carrying on their traffic? There is no doubt that wherever popular opinion has been aroused on any subject in which the public safety is at stake, it has unhesitatingly declared in favor of State action. Incidents of this are numberless outside the railway field, as well as in it.

The first State railway commissions were established in obedience to an overwhelming public sentiment aroused by a few terrible accidents, and there are now 26 States which have railway commissions. The powers and duties of most of these bodies are vastly broader now than at first. Evidently, then, the voice of the omnipotent public is that the matter of safety should not be left in the hands of the railways alone.

Now it is growing more and more apparent that the days of an efficient State control over railway appliances and methods are past. One great system may extend over many States; and to subject it to the conflicting laws and requirements of half a dozen legislative bodies as regards its methods and appliances, is plainly unwise. The railway traffic of the country, too, is rapidly becoming unified, and the tendency is more and more to carry it on, as if all the railways of the country were owned and managed by a single corporation. Especially is this true as regards freight traffic.

State railway commissions can supervise bridges and permanent way without interfering much with each other. But when it comes to the adoption of an automatic freight car coupler or continuous brake, their independent action would do far more harm than good. It seems certain, then, that any legislation with regard to these two appliances must come from the general government.

But these are by no means the only reforms in which national interference is plainly far more appropriate than State interference. Safe methods of heating and lighting cars and operating trains, for instance, cannot be taken up by State legislatures and acted upon, save in the most general way, else we might have the spectacle of a company being obliged to operate its trains or light its cars by a different system when its road crossed a State boundary.

There are few cases in which legislative enactment really furthers a reform unless the law commends itself as just, wise, and practicable. However excellent State laws may be, and however wisely drawn, they all must necessarily fail to secure uniformity. The State railway commissions have many of them done excellent work in the past, and much work still remains which may properly be intrusted to them; but the rapid progress in the unification of our railway system is fast making apparent the fact that future control must be largely entrusted to the general government.

Another most important fact to be considered in this connection is that it is for the interest of the railways, as well as the public, to have a certain measure of control exercised by the general government; and especially to have vested in a single authority the power to fix on and compel uniform action. This is true of matters connected with the financial and traffic departments, as well as the operating departments; but we will discuss here only those matters of safe operation with which the latter department is concerned.

Let us take the one matter of automatic couplers and brakes. It was explained in our issue of Dec. 21 what a great financial saving would result from the adoption of these appliances on all the freight rolling stock of the country.

This, with the great saving of employés' lives and limbs, makes the reform of the greatest importance. Corporations controlling a very large proportion of the rolling stock of the country have set about the reform in earnest. But they will be debarred from reaping the full returns from their investment until equal progress is made by companies now delinquent in the matter.

Again the commencement of the reform has been delayed many years by the lack of any central authority to say what type of coupler should be standard.

The delay was not due to the expense, nor to a lack of realization of the calamaties due to the link and pin coupler, nor to the lack of a coupling good enough mechanically for the service. The root of the difficulty was, who should decide what one style of coupler should be the standard; and if that one point were settled authoritatively, as well as in a merely advisory way by an unofficial body of experts, very much more rapid progress in its adoption would certainly be made.

There is, then, a legitimate field for some authority over the railways in this matter of safety appliances, both in the interest of public safety and for the benefit of the railways themselves. How this authority should be exercised so as to be at once effective and duly cautious and conservative is a more difficult problem.

It is admitted at the outset by all intelligent men that the obstacles in the way of any beneficial interference of the government with railway technical matters are very great. Suppose Congress were to take upon itself the task of deciding what type of switch should be used, or what code of rules should be adopted for train operation. Yet such action would be no more preposterous than many of the State laws which have been passed relating to railway operation. Surely Congress itself is wholly unfit to discuss or regulate the matter of railway safety appliances.

But Congress may delegate its powers to some competent body. It may create, let us say, a Commission on Railway Operating Appliances, to co-operate with, or work under, the Interstate Commerce Commission, and leave that overworked body to confine itself to the supervision of financial and traffic matters. Undoubtedly much good might be hoped from the action of such a body, provided the right sort of men were secured for it. Undoubtedly, too, there would arise opportunities for the gravest abuses through the action of such a body. The men comprising it would need to be not only mechanical experts, versed in every detail of both the theory and practice of railway engineering, but men of such moral stamina that they would be absolutely unpurchasable, no matter in what apparently honest manner the bribe were conveyed.

Changes which are really in the line of improvement are thereby rendered more difficult to introduce. For this reason especially the hasty adoption of any standard without most careful examination and lengthy trial is always to be deprecated.

The selection of the men to compose such a commission would be a difficult enough task for one with the best intentions; and when it becomes necessary to consider the claims of rival political parties and factions and geographical sections of the country, there is much danger that the make-up of the commission would not be such as to give any great confidence in its conclusions.

One of the dangers which would constantly menace such a body was well illustrated at the convention of the State Railway Commissioners with the Interstate Commerce a year ago, when an attempt was made to have a paper read before the convention describing a patent electric semaphore signal, and came near being successful. The commission would lose its prestige at once if its time were mostly taken up examining the multitudinous inventions which are constantly being turned out by men unfamiliar with elementary principles of engineering. On the other hand, it would be an error even more serious to have the commission a barrier in the way of real improvements. This is indeed a danger which always arises with the adoption of a uniform standard in any department of engineering work.

But while the dangers of investing a government commission with authority to control railway methods and appliances are great, it is to be noted that these dangers are almost wholly neutralized if the commission is given only advisory powers. If such a commission recommends faulty appliances through ignorance or for a consideration, its advice will certainly be taken at its real value; the only real danger to be feared in such a case would be that it might bring the general idea of government control into disrepute.

Experience in the past has shown that the mere recommendations of State Commissions, when manifestly wise and just, have, as a rule, been followed by the railways. But the advice of a board of expert engineers, thoroughly versed in railway operation, would carry far greater weight; and public opinion, which is, after all, the supreme law, would so support their recommendations that few railway managers would venture to disregard them.

One of the first duties of such a board would be to collect statistics of all railway accidents by special district agents, and to carefully investigate all those which promised to shed any light as to the best forms or designs of either permanent way or rolling stock details. Such statistics would be an invaluable guide as to many matters concerning which we are now working in the dark. It is certainly a work which it would be for the good of all to have done, if only we could be sure it would be well done.

Returning to the question as to the best means of selecting an advisory commission, there can be no real objection to giving the railway companies a voice in the selection of its members. It is of even more importance to them than to the public that the commission should be composed of intelligent, honest, and capable men. It is hardly likely that any bias in favor of the railways would interfere with their duty to the public; and, in fact, in most cases the interests of the two are identical. Take the selection of a uniform coupler for car heating, for instance. An expert appointed by the railways would be false to their interests as well as false to his oath to serve the public if, to delay progress in continuous heating, he voted against the recommendation of a really good device.

A great obstacle in the way of securing such action is that there is no way in which the various railways can legally act together. If the traffic associations, or even the associations of departmental officials, as the Master Car Builders' Association for instance, were organized under a definite charter and could be legally recognized, the difficulty would disappear. In some way or other, however, it should be possible for the associated railways of the country to choose, say, one-third of the experts composing such a commission; and even the most zealous enemy of the railways could not object to giving them this much representation.

Certainly it would be most unwise to begin government control over matters where so much property and so many lives are at stake in a hasty way. An expert commission should be organized, with advisory powers only at first, and it is not at all certain that any absolute authority ought ever to be given to a commission.

In the case of many automatic freight-car couplers, or continuous heating, the railways only need to be convinced of what is best, and what is to be generally accepted, to push the improvements with all dispatch. In the case of others, like the use of the block system, some stronger "moral suasion" might be needed. In such a case it might be wise to provide that exemplary damages should be paid in every case where accidents had taken place through the lack of safety appliances recommended by the government commission.

There is another indirect means of reaching companies which prove manifestly dilatory in their action. In an article in our issue of Dec. 21 it was pointed out that to delay the introduction of automatic couplers is a direct injury to all the companies who are now rapidly applying them to all new cars. It delays by so much the time when they can reap the full benefit from their investment. It has been proposed, therefore, that it should be made a lawful reason for refusing cars from another road that they were not fitted with the M. C. B. standard couplers. If the bonds holding the traffic associations together were considerably stronger than they are, this might work very well. Under present conditions, however, a company would hesitate to refuse a link-and-pin car unless they knew their competitors would do the same. Still, the knowledge that such cars were liable to be refused in interchange, say in three years, would have great weight in inducing lethargic boards of directors to let the dividend rate stay where it is, and make a round appropriation for couplers.

On the whole, however, any legislation by Congress regarding the adoption of special devices is to be deprecated. The agitation of the subject which has been carried on by the organizations of railway employés will result in greatest benefit in the long run to all concerned if it secures the establishment of such a commission as we have outlined. The sooner such a commission is appointed, and the sooner it takes action on some of the most pressing of the work which confronts it, the better it will be for both the railways and the public.

To secure the enactment of such a law all intelligent railway officers should lend their influence and aid. Had the enactment of the Interstate Commerce law been preceded five years by the appointment of an able commission, with merely advisory powers, the enforcement of the present law would have been much longer delayed, and the railways would have conformed to it with far less friction. Old abuses which had become necessities would have been gradually wiped out.

Any one who will carefully read the indications can see that government action of some sort in the matter of railway safety appliances is absolutely inevitable. If it is put off until the public will have nothing less than absolute control, we may have legislation that will work serious injury. If, on the contrary, railway men of influence will recognize the inevitable drift of things and put themselves in harmony with it, if they will aid in the enactment of a moderate and well-considered law creating an expert commission and endowing it with unlimited powers of collecting knowledge, but prohibiting it from authoritative interference, we shall be indeed in a way to improve our railway practice, securing at once the essentials of safety and economy.

The Properties of Alloys.

There is no fact of physics or chemistry more curious than the seemingly lawless and arbitrary way in which slightly different proportions of the so-called "elements" will produce a mixture of utterly different properties. The effect of carbon upon iron is a familiar example, but that seems less surprising since the two elements are so entirely dissimilar in their nature. The same is true of the effects of adding phosphorus, sulphur, silicon, and what not, to the familiar metals.

When we take mixtures of metals only, however, like those of iron, copper, zinc, tin, lead, aluminum, silver or nickel, it does seem as if, granting that we have a fair knowledge of the real properties of these metals, we ought to be able to predict with some approach to certainty, something of the nature of the product which will result from mak-

ing alloys of them in varying proportions. Yet such is not the case in hardly a single instance; it is even less so with the pure metals than with the various non-metallic elements which are mixed with metals. We do know, for instance, that the effect of adding more and more carbon to iron is continuously to harden it up to what we may call the saturation point of about 5 per cent. Although the effect of adding carbon is in some other respects quite lawless, yet something like a law is discernible in this, the most prominent effect. The same is even more true of phosphorus and some other like elements.

Yet, when it comes to the effect of adding one metal to another, we are absolutely in ignorance as to what the effect will be, except as the mixture may have been tried before.

No law, nor approach to a law, has been accepted; no theory, nor approach to a theory, has been advanced from a responsible source—or indeed from any source—by which we can either explain the anomalies which experiment determines, or predict the result of a previously untried mixture. That there is some law underlying all this seeming lawlessness is extremely probable. That it would make simple what now seems so complex is equally probable. That it will some day be discovered is surely a reasonable belief; but it cannot be claimed that at present science even seems to be tending toward such a discovery.

The brief and imperfect graphical exhibit of the properties of certain aluminum alloys which we make in another column, is a new illustration of the peculiar lawlessness noted. Starting from pure copper and ending in nearly the same spot with pure aluminum, the two metals not having any very great difference in the physical properties shown—elongation and ultimate tensile strength—we "swing around the circle" in a most curious fashion as we add successive percentages of aluminum from 1 to 99 per cent. There were, it is true, small percentages of other elements in the particular compounds whose properties are shown on the diagram, so that it is not strictly true that it shows results with these two metals only; but the difference is of detail only. The variations in the latter case would be the same in nature, if not precisely of the same extent.

He must have a dull imagination who is not impressed by such a showing with a sense of the vast field which yet remains to be explored in metallurgy, and with the great results which might be expected from an extension of our knowledge to include *why* these things happen, as well as the bare fact that they do happen. Our situation in respect to metallurgy is now much the same as it was in respect to astronomy before the true form of the solar system and the law of gravitation were discovered. Astronomers might observe and record isolated facts by thousands, and they did so record them, but they could make no real progress in knowledge of astronomy. Such observations went on for centuries, and were so extensive and careful as to enable eclipses to be predicted with considerable accuracy long before any rational theory of the universe had been formed, yet all our real knowledge of astronomy dates from the discovery of the beautifully simple *laws* by which the apparent complexity of astronomical processes is governed.

Thus, even after the Copernican theory of the solar system was accepted it was supposed that each planet moved in an exactly circular path at uniform velocity, and the discrepancy between this theory and observed facts was explained by assuming that each planet had a separate centre of motion with which the sun had nothing to do just as we now assume that diverging results of different mixtures of the same metals are underlaid by no common law, but are each a law unto themselves. That there are some general laws which will bring order out of chaos when discovered is as probable in the one case as in the other.

The most striking of all exhibits of the independence of alloys of the properties of the parent metals, because of exceptionally wide range, was probably a little triangular model of the tensile strength of the various bronzes, prepared by Prof. R. H. THURSTON some years ago, and shown in his treatise on "Materials of Engineering."* The tensile strength of all possible triple alloys of copper, tin and zinc is approximately shown in this diagram by the simple method of showing at each corner of an equilateral triangle the strength of the pure metal, copper, tin or zinc, and locating intermediate points according to the proportion of each metal. Thus, the boundary lines of the triangular areas show alloys of two metals only.

On the line between the copper corner and the zinc corner all possible alloys of those two metals are shown, a 90 per cent. copper alloy being placed at one-tenth of the way from copper toward zinc, and a 10 per cent. copper alloy standing at the same distance from the zinc corner. The copper-tin alloys and tin-zinc alloys occupy the other two sides, and in the interior space come the triple alloys, arranged in a way which will be readily imagined, an equal mixture of all three metals standing in the very centre of the area. Regarding the tensile strength of each mixture as an elevation, either a model or "topographical map" is readily constructed, which, if there were some approximately uniform rate of change, would approximate to some gently sloping plain, or some simple convex or concave surface.

As a matter of fact such a "topographical map" is more lawless and irregular than any but the roughest of natural topography in mountainous regions. At half a dozen different points, having no apparent relation to each other, any change of composition whatever results in either increasing or decreasing the tensile strength. Sometimes the increase is marked and sharp; sometimes it is small and almost insensible. The places in which great changes of any one or two metals either have no effect at all, or a surprisingly great effect, are numberless. A more hopeless looking diagram from which to evolve any general law can hardly be imagined, and yet this is a diagram of only one property of these alloys. If we take some other property, like ductility or resilience, or still more if we add any fourth metal, the complexity becomes increased many fold.

It cannot be expected, therefore, that the properties of the endless possible alloys of a new commercial metal like aluminum, which has only lately become anything more than a laboratory toy, can be fully discovered or understood for a long time to come, unless indeed some one should suddenly hit upon a theory to explain all these vagaries and reduce them to law, which may happen any day, but toward which science does not now even seem to be tending. The "cut and try" process is necessarily a slow one. To use an illustration which we have used before in discussing Prof. THURSTON's diagram of the bronzes, we are necessarily proceeding now in metallurgical matters much as the Japanese are stated to have done by the Autocrat of the Breakfast Table in relation to a remedy of their's called acupuncture," which consisted of sticking needles in the human body as a cure for certain diseases. Not being blessed with a knowledge of anatomy, they simply "put the question to Nature" by random experiment, marking with blue spots on a doll where entrance of the needle was found to be safe, and with red spots where it was found to be unsafe. Such a process, if continued long enough, doubtless resulted in a pretty fair knowledge of the properties of the human body *in that one respect;* yet after all it would not, if continued forever, give much real knowledge of anatomy. The only real way to gain the broader knowledge, is to go to the heart of the mystery, which lies beneath the surface.

This can be, and has been, done for anatomy, for the mystery is merely material, and readily investigated; but, unfortunately, there is no like way to go beneath the surface of metallurgical processes, and so solve a mystery which probably can only be cleared up by a more correct theory of the very nature of matter than any we now have, if, indeed, we can be said to have any theory. From one point of view it seems possible that the mystery will remain for ever insoluble, for unquestionably it will deal with the relation of particles far too small for the human senses to discern directly; but an age which has seen the heavenly bodies weighed in the balance, and their nature and motions determined from light which has taken untold ages to reach us, need not be appalled by this. Perhaps the only real difficulty is that the hour and the man has not yet come. When they do come, they may vastly extend the range of our knowledge and power by methods so simple as to make it seem amazing that it should have taken so long to do so.

* Part 3, pp. 427, 435.

CORRESPONDENCE.

An Incident of Caisson Work.

HILLSBORO CENTRE, N. H., Feb. 4, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Reading the next to last paragraph in Mr ORMSBY'S article on deep foundations in your issue of Feb. 1, page 115, recalls an incident related to me by E. R. HORTON, of St. Joseph, Mo., during the construction of the Missouri River bridge at that point, which was opened for traffic about June 1, 1873. While sinking one of the caissons it was observed to have gone out of alignment 9 ins., the probable cause being escape of air under over-pressure on one side of the caisson, acting on the sand in a manner analogous to that of the water jet in pile driving, displacing so much of the inclosing material as to diminish outward pressure on that side, and allow a lateral movement of the caisson. Measures were at once taken to provide for a similar escape of air on the opposite side of the caisson, resulting soon after in the return of the structure to its proper alignment, and the experience thus gained was thereafter utilized in sinking the remaining caissons. I have an indefinite impression that Mr. WILLARD S. POPE, President and Chief Engineer of the Detroit Bridge Co., builders of the entire bridge, read a paper on the subject soon after at some meeting of civil engineers. The experience thus gained may have been superseded by the wider knowledge since obtained in that line, but a note addressed to Mr. POPE would doubtless bring out interesting details on the subject.

L. W. DENSMORE.

The Cubic Capacity of Cement Barrels.

68 LACLEDE BUILDING,
ST. LOUIS, Jan. 30, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Can you tell me what is the capacity in cubic feet of a Portland cement barrel? I have examined all the books to which I have access—a goodly number, including Trautwine, Molesworth, "Knight's Mechanical Dictionary," "Spon's Supplement," Newman on Cements, Encyclopedia Britanica—everything, and cannot find any written record. Everything runs to pounds. I have asked all the engineers, and none of them can tell me, although some of them have a memorandum of it in some of their note books, not at hand. There is a fortune for somebody who will compile a list of the cubic capacities of the various barrels of commerce. Yours truly, X. Y. Z.

[We thought we had notes on the cubic capacity of some American cement barrels, and are convinced we have somewhere; but, like those of the other engineers referred to, they are "not at hand." If any of our readers having notes will send them in we would be pleased to compile the list sought for, and think it would interest others than our correspondent. We have looked through other sources of information than those mentioned above, but they are all silent on the question of cubic capacity. —ED. ENG. NEWS.]

Standard Rail Sections—Erie & Wyoming Valley R. R.

DUNMORE, Pa., Feb. 3, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Your valuable article in regard to the Erie and other standard 80-lb. rail sections will aid materially the selection of a type. The strife for a standard should not be continued longer, and at such tremendous expense. Could you now submit this "Erie" pattern to the differ-

ent "mill men" for their opinion, and ascertain what changes in it, if any, they would suggest to produce the best rail, it would help much to crystallize the varying opinons, and settle for all time this annoying question of standard sections.

A. D. BLACKINTON,
Resident Engineer.

[It would be unbecoming for us even to attempt anything of the kind at present, in view of the fact that a large committee of 13 members of the American Society of Civil Engineers now exists, charged with the special duty of devising and recommending a series of standard sections, varying by 5 lbs. between 40 and 100 lbs. per yd. The propriety of any committee undertaking this work has been questioned, and a letter ballot on it is now pending, as we explained more fully at the end of our article last week; so that it is not likely that anything will be done by the committee until the letter ballot has been had, and proves to be favorable to the continuance of the committee, as it no doubt will. Afterward, the first work which the committee will do will probably be in substance what our correspondent suggests. We believe, and in fact we know, that the time is ripe for the establishment of standards, which will meet all but universal acceptance. That anything whatever can settle the question "for all time," however, we do not believe. Metallurgical and mechanical changes will no doubt indicate from time to time that modifications are desirable, and they will no doubt be made by a subsequent or continuing committee, but only after thorough investigation has shown that it is generally felt to be desirable, and not on hasty and probably erroneous personal impulse.—ED. ENG. NEWS.]

More About Derailing Switches.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Some of these days one of the brilliant contrivances above alluded to will "land a train in the ditch as gently as possible," to use your own elegant and assuaging diction, with the result, neither gentle, elegant nor assuaging, of killing, roasting and injuring 30 or 40 people; and then, perhaps, it will be sapiently remarked that a device to throw trains off the track is, after all, a most peculiar thing to introduce on a railroad as a safeguard, if it may be thus termed, and the only one, against a running by of signals.

To begin with, there should be clearly distinguished the two cases of entirely different value; the one, of a crossing of two railroads; the other, of the crossing of a railroad and a watercourse by means of a drawbridge. In the first case there is not one chance in a hundred, as crossings go, that an engine going ahead, without the right of way, would find a train upon the crossing when it got there; in the second case, there is a certainty that, without the right of way and with inability or neglect to stop the train, the offending engine and train attached will go into the water. Clearly a derailing device may well be proper in the second instance, when it is improper, to use no harsher term, in case of the ordinary railroad crossing.

The object of this communication is, however, to urge the application in both cases of some device constructed with the exercise of a little more of the reasoning powers of man, and less dependent for success on "main strength and stupidity."

Suppose one, two, or more torpedoes were automatically pushed upon the rail, 1,000 or 2,000 ft. from the danger point, whenever there *was* danger, and in the same way withdrawn when the signals indicated a right of way; of course, the mechanism pushing on and withdrawing the torpedoes to be interlocked with the signal system.

With such a mechanism, may it not be reasonably assumed that no engineman could explode one of these torpedoes without having his attention instantly aroused, and his taking proper measures to stop the train?

The derailing device might still remain in the case of drawbridges, but would come into use only in cases of extreme misdemeanor, such as drunkenness, or of accident to the engineman himself; in other words, almost never; and at railroad grade crossings the traveling public is safer without a derailing device, in the writer's estimate of the chances involved, than it is with it. Indeed, as may be added in closing, the derailing device is currently spoken of as a mechanism to detect and punish the engineman and his engine; and without apparent disclosure on the part of the speaker that the larger interests of the traveling public have any place in his thoughts and mind.

C. H.

[*Ne sutor ultra crepidam*: Let the shoemaker stick to his last. Our correspondent is one of the first of living experts in certain hydraulic matters, but he must pardon us for suggesting that this does not make him an expert in train-handling nor in signal engineering; any more than the expert in the latter becomes thereby qualified to duly weigh the extent of the fire risk from using gasoline for car lighting. It is not true that when a train runs by danger signals at a railway grade crossing "there is not one chance in a hundred that it will find a train upon the crossing when it gets there." On the contrary, there is about an even chance that it will find one there, as such trains have done in hundreds of instances. On the other hand, in the numerous cases in which trains have run off of derailing switches, no serious harm has ever happened to any one of them, if our memory is not at fault. Certainly such harm is very rare. Our correspondent seems to have an impression that all derailments at speed are likely to have serious consequences. Such is not the case. It has become a truism of railroading that derailments on nearly level ground, with no fixed obstruction to run into, rarely do any serious harm to either life or property.

The torpedo alternative suggested is not a new one. Such a device is in use on the New York elevated railways and in many other places, and it is a most excellent device; but its best use is when the whole apparatus is reasonably near to the signal man, because, unlike the derailing switch, it is not positive in its action. The torpedoes may be missing, or wet and spoiled; or the brakes may fail to work; or the engineman may be drunk or in a fit, or asleep; or the reverse lever may be broken, or various other contingencies may intervene, among which is, that the engineman may be thinking of his sweetheart and so temporarily deaf as well as blind. It is most unlikely, of course, that both sight and sound will be appealed to in vain, and it is this which makes the device an admirable and useful one; but sad experience has made it an axiom of signal engineering that nothing may be "reasonably assumed" except a *positive* check or else a probable accident. It is for this reason and not for the silly motive of "detecting and punishing the engineman" that the derailing switch is preferred; although the additional effect of certain exposure to *prevent* negligence is not to be despised. Just as many a man will neglect the "still, small voice" of conscience when he will beware of state prison, so many a man would be indifferent to cracking off a few torpedoes which no one but himself would notice, when he would be constantly alert to keep his train out of the ditch.—ED. ENG. NEWS.]

The Brooklyn Bridge Terminal Plans.

OWEGO, Tioga Co., N. Y., Jan. 24, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Jan. 11, I notice an article on the Brooklyn Bridge terminal plans, and a sketch of the adopted plan of tracks, etc. It must be plain to any experienced railroad man, especially to one who has had experience in handling large and mixed crowds of people, that, if this plan be carried out, it will be the worst *death trap* ever sprung on an unsuspecting public. A very little excitement will cause a panic in a crowd of human beings. How many cool heads do you find in a crowd of ten or twelve thousand people? Scarce 1 per cent. I have had considerable experience in handling large crowds of these same people, as I was superintendent of the Brighton Beach R. R. during four years of its busiest life. The first point for consideration should be how best to protect the patrons of the line. The best plan would seem to be to keep them away from possible danger. I inclose a rough sketch of how I would arrange tracks for the Brooklyn Bridge. It is not drawn to a scale, but it is easy to do so.

I would run four cars in each train and use compartment cars. I would discharge a train every minute, and carry each way 16,000 people every hour, or as fast as they could get from the street to the platforms. The cars should be handled by cable entirely, with one single track at each end of the bridge long enough to hold, say six or eight cars, and use only the front cars as needed. It is simple, economical and safe. There is but one switch and one frog at either end to go over, and the chances for breakage or derailing are reduced to a minimum. A signal tower should be placed in the fork of the tracks, just outside the station, which should be turned against incoming trains until the track is clear. Compartment cars can be made as warm in winter as cars with only end doors. With two seats to each compartment, with sliding doors, an arrangement could be made so all the doors could be opened from either end of the car or by passengers occupying the compartment. And it seems to me that, when dispatch is so necessary, that compartment cars are a necessity, as they can be loaded and unloaded in 20 seconds, and the cost of operating be reduced nearly one half.

W. E. DORWIN.

[No steps have yet been taken to carry out the plans referred to, and it is a pretty safe prediction that none ever will be taken—or, at least, that no attempt to put the plan in operation will ever be made.—ED. ENG. NEWS.]

The Stadia in Topographical Surveying.

NEW YORK, DEC. 19, 1889.

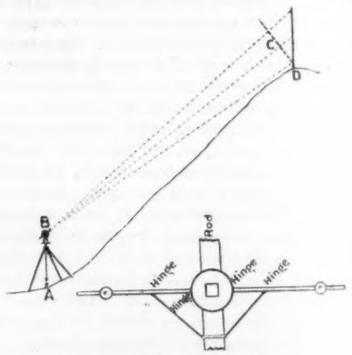
TO THE EDITOR OF ENGINEERING NEWS:

SIR: Permit me to ask your valuable opinion upon a subject that may also interest a great many of your readers, viz., the use of the stadia in topographical surveying and an improvement in such work, which I think can be effected, but would be glad if you would point out any objection that may occur to you.

By using the stadia in my transit I have often been able to do the work of almost a full working field party with my rodman alone with quite enough accuracy for the best topographical work and in half the time. For instance, suppose I was following out the ridge line of a range of hills through dense forest: I would first go along the ridge and leave pegs at each angle where it changed direction or slope; then start with my instrument at each alternate peg, taking back and fore sights and cross sections down the sides, reading distances and angles at one operation.

Having my pegs driven to the surface of the ground and my plumb line set to a certain length, I could always set up at almost exactly the same height above ground, and avoid shifting the target or the rod for each sight.

This system worked admirably, but the drawback I found was the liability to error in keeping my notes unless extreme care was used, because as an uneven line with vertical angle sights often of 15° to 20°, the correction for the inclination of the rod is considerable, depending whether the sight was taken up or down hill, to add or subtract it, and errors in such a case would often be cumulative and render the work useless. It will also be seen that the method sometimes adopted of having a right angle sight on the rod to enable the rodman to incline it according to the inclination of the hill, even when most carefully done, only eliminates part of the error, as the instrument at *A B* remains vertical and the



Proposed Stadia Device.

rod inclined, the distance rod *B C* is not the true distance required, viz., *A D*. To eliminate this error entirely, therefore, I am now having a transit made with the stadia hairs vertical instead of horizontal, as usual, and a simple attachment to the ordinary Philadelphia rod, consisting of two very light, graduated bars, hinged to the side of the target so as to stand out horizontally when needed, with a very small target on each. The rod is thus held vertical *always*, and no correction is needed at all.

I feel sure that, with the disadvantage removed that I have indicated above, the use of the stadia in a large variety of cases will come into more general favor, and produce very superior results to pegging up the sides of hills with chains, etc., besides the rapidity with which all the operations can be effected with a degree of accuracy that is surprising when tried.

Should you see any objection to the device suggested above you need not, of course, publish my delusion. I will be thankful enough for your reply, and remain yours very truly,

J. T. FORD, Assoc. M. Inst. C. E.

Notes and Queries.

Col. LEONARD J. WRIGHT.—Several correspondents inform us, in answer to our recent inquiry, that Col. WRIGHT died two years ago, having previously resided for some years in Newtown, Conn.

C. W. McM. asks: Can you refer me to any reliable information on the subject of railway operation which will give data on the starting and stopping of trains and engines? That is, I wish to know at what velocity, under favorable circumstances, an engine will be going at the end of 100 ft., 200 ft., etc., and when can it attain its maximum velocity?

The fullest information on this subject will be found in Mr. WELLINGTON'S "Economic Theory of the Location of Railways," pages 331-375, 434-481, 496-535, 550, 910-924, etc.

W. B. G. asks: 1. Is the candle-power of arc lights usually measured with the globe or without? [Without.] If without, how much does the porcelain globe reduce the

effect? [All the way from 10 to 12 per cent. (clear glass) to 40 per cent. or more with full ground glass or clear porcelain.] 2. What is the candle-power of the ordinary fish-tail burner, consuming 6 ft. of good coal gas per hour? [20 to 25, or more; varies with gas.] 3. What kind of a "gas light" is referred to in your clipping from the Montreal *Star*, p. 341, Vol. XXII.? [Standard Montreal street gas lamp, probably some 20 to 25 c. p.]

W. F. P. SEALY, Superintendent of Water-Works, Potsdam, N. Y., writes as follows: Can you put me in the way of obtaining some system of fire-alarm that would be practicable for us to adopt? We have no satisfactory system, and at three recent fires a great deal of time was wasted in giving the alarm. It has been thought that a large gong might be rigged at the water station and sounded by applying power. If you can give me any information it will be gladly received.

There are several good systems of fire-alarm. In our issue of Jan. 25 it was mentioned that the Gamewell system was being put in at Pottsville, Pa. Mr. E. D. Brady is the local agent at Pottsville.

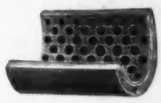
Metalined or Oilless Bearings.

The preparation of bearings by the metalining process, enabling them to be run for years without the application of oil, is no new thing, bearings of this sort having been in use a dozen years or more. But as many engineers and machine designers are unfamiliar with this process, a few words as to its uses and its limitations may be of interest.

Its most important use is for bearings on which the use of oil is for any reason undesirable or whose oiling is likely to be neglected. It is also desirable for bearings which, on account of their speed or position, it is difficult to keep properly oiled. With a metalined bearing no oil whatever is used; and while it is not claimed that the friction is less than with a bearing kept well lubricated, the friction is reduced enough so that the bearing runs without heating.

The metaline, which is a mixture of several substances, one of the most important of which we judge to be plumbago, is ground to a fine powder, and is pressed into little cylindrical blocks from $\frac{3}{16}$ to $\frac{5}{16}$ in. in diameter, according to the size of the bushing to be prepared, and of a length a little less than the diameter. The bushing is cast in halves, and is made of gun metal. Each half is bored with shallow holes as close together as they can be placed, and with the alternate rows staggered, and into each of these holes one of the metaline plugs is placed and driven home with a set punch and jeweler's hammer. The plugs are then filed flush with the bearing surface, first with a half-round bastard-cut file and afterward with a fine one.

The appearance of a half bush with the metaline plugs inserted is shown in the accompanying engraving. It will be seen that a large proportion of the surface of the bearing consists of metaline; the particles of this which are abraded act as a lubricant for the surface of brass between the plugs.



As has been shown in actual use, the wear of metalined bearings is exceedingly small. If the speed and pressure are not excessive, they will run for six to ten years, and often at the end of that time the wear in the brass is so small that by putting in new metaline plugs—an inexpensive operation—the bearing can be made as good as new.

The first cost of metalined bearings is quite high, but the fact that no expense for lubrication is necessary serves to offset this for places to which they are adapted.

The limitations to the use of these bearings are quite clearly defined. They are not intended to compete with bearings where oil may properly be used. They cannot be used for bearings carrying heavy loads at high speeds, and, most unfortunately, they will not work well in a temperature above 275 or 300 degrees. It is also necessary to their successful working that the shaft and bearing be set up in proper shape, the shaft well lined, and the bearing carefully fitted. If this is not done, of course the strain is not equally distributed over the surface of the bearing, and an excessive pressure on one part soon cuts out the bushing. The manufacturers do not advise the use of metaline for bearings smaller than $\frac{5}{8}$ in. or larger than $3\frac{1}{2}$ ins.

Just what are the limitations of pressure per square inch and speed per minute beyond which the use of metalined bearings is not advisable, we have not been able to ascertain. Small bearings lightly loaded, however, are safely run up to 2,500 or 3,000 revolutions per minute. The manufacturers are now making some experiments with a view to the use of metalined bearings in dynamo work. They are running a $1\frac{1}{8}$ in. shaft at 750 revolutions per minute. This shaft is loaded with a weight of 250 lbs. at the centre and is run by a 4-in. belt. The metalined bushing is about 7 ins. in length at each end of the shaft, making the pressure per lineal inch of bearing about 20 lbs.

Metalined bearings have been most extensively used for loose pulleys in textile mills, where the fire danger from hot bearings, or from dripping oil, and the danger of soiling goods by the latter, make a bearing which requires no oil a valuable acquisition. For loose pulleys in many other situations, where the frequent oiling which they require is liable to be neglected, metalined bushings will be found to be a great economizer of labor and expense. The Boston & Lockport Block Co. are using metalined bearings for their pulley blocks. For coffee roasters, where the bearings are subjected to considerable heat, metalined bearings have been found superior to oiled bearings. Still another important use to which these bearings have been largely applied is for elevator sheaves.

Without urging the use of these bearings for situations where well-oiled bearings are the proper thing, it seems certain that their merits are not as generally appreciated as they should be by machine designers. Small pumps, dynamos, electric motors, and many other machines for household use are apt to be oiled neither often nor regularly. In many cases, where the nature of the work is such as to permit the use of metalined bearings, they would add to the life of the machine, save frequent annoyances from cut bushings, and by their cleanliness and the fact that they need no attention would popularize the machine on the market.

These bearings are made by the North American Metaline Co., 37 Bleecker street, N. Y.

The Sprague Electric Locomotive for Mines and Freight Tramways.

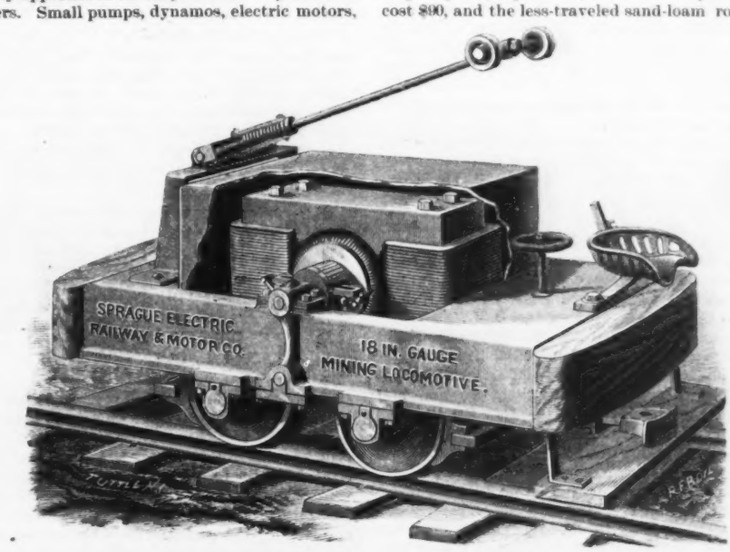
A new type of electric motor, or locomotive, for use in mineral mines, freight tramways, etc., is now being manufactured by the Sprague Electric Railway and Motor Co., and is here illustrated.

This locomotive is simple in design, powerful and compact, is especially fitted to operate narrow-gauge lines, and in all its parts is planned with special reference to the serious, every-day work required of such machines. In the locomotive shown the gauge is only 18 ins.; but it can be accommodated to any gauge in ordinary commercial use. As shown, all the working parts are boxed in to protect the machine from damage.

The speed of the motor is under complete control by means of a switch which throws the winding of the field into different electrical combinations, thus varying the speed without the use of wasteful resistance. The direction of rotation is governed by the same switch, so that the operation is so simple that it can be entrusted to any ordinary workman.

Any system of conveying the current from the dynamo to the locomotive can be used, either using the rails as one side of the circuit for the return of the current, or else employing a complete metallic circuit by the use of a double overhead trolley wire. In this latter case a trolley pole shown in the view, carrying at its upper end two trolley wheels for making running contact with the overhead wires, is attached on the rear of the locomotive car.

This mining locomotive is another proof of the rapid introduction of electricity as a source of power and light into modern mining practice; and while it indicates a growing demand from mining companies for such machines, it also shows the ability of the leading manufacturers of electrical appliances to meet such demands.



The Sprague Electric Locomotive.

Notes on Country Roads.

Mr. S. R. DOWNING, one of the Pennsylvania State Road Commissioners, writes to the Pittsburg *Dispatch* that he believes in macadam roads, and strongly advocates the constant employment of an engineer in each county to direct the making of roads. He says that macadam will save money even on present expenditures for road repairs on much-traveled roads. The average annual cost of repairs in a township may be $50 per mile; the worst clay roads may cost $90, and the less-traveled sand-loam roads may amount to $10. A new macadam road need not cost for ten years over $10 per mile annually for repairs. Thus by using stone, says Mr. DOWNING, about $80 per mile can be saved annually on the worst roads, and ten miles of road in ten years would save $8,000, or enough to build one mile of 6-in. macadam road. A money tax and constant attention to repairs under intelligent supervision is the only secret of success.

Mr. BALLORD, another Commissioner, recommends the use of the scraper and gravel with roads not macadamized.

Mr. CHAUNCEY B. RIPLEY, of Union Co., N. J., has been prominent in securing the excellent highways found in that county. In an interview in the New York *Times*, Mr. RIPLEY speaks as follows of the practice there adopted:

> Respecting work on the country roads, the work in Union Co. is progressing slowly, but, according to contract, rigidly in all cases. Our public roads are generally laid out 66 ft. wide. Of this width, one-fifth, or about 13 ft. on each side, is allowed and used for sidewalks and shade trees. The country roads are macadamized only 16 ft. in width, or 8 ft. on each side of the centre line, which the surveyor first defines, and which, when found, controls all other lines in the progress of the work.
>
> First among the essentials of a first-class road is drainage. The contract, specification, and drawings all provide for such a grade as shall carry off all water from the surface of the road and that which percolates through the stone. Before any stone is laid the roadbed is perfectly graded, with reference to shedding water toward the sides, as well as carrying it off lengthwise. The centre of the roadbed is higher and the slope to each side is regular. A shoulder is left on each margin of the 16-ft. bed, so that the foundation stones cannot spread. The roadbed is made smooth and rolled before any stones are placed on it.

After its preparation is completed, a layer of blocks of stone about 12 ins. long by 6 or 8 ins. on the sides is laid, each stone by hand. Each stone stands an inch or so away from other stones. The stones of the first layer are pretty uniform in size, and of trap rock, and crack or split easily when struck with a stone hammer, which is used on the top of each stone till all are broken into, say, half a dozen pieces. The broken pieces fall down wedge-shape, spreading so as to fill the vacant spaces left between the blocks, as originally laid, and form a mass of wedged stones that will stand in the position they are left by the hammer forever, we may almost say. After this the roller is applied and the stones are packed by rolling. Then a layer of larger stones is placed upon this foundation, say stones of the size of 2 to 2½ in. on a side. This layer is then rolled, and a finer grade is used on top, till stone dust and gravel complete the evenness of the surface. The roller now in use on the Union Co. roads is a steam roller, and has a pressure of 12 tons.

The cost is about $10,000 a mile, I judge, by observation and imperfect reports. It is not far from that sum I can safely say. It seems a great deal to one not acquainted with road making. It is not. We have a few good roads in our country that have not cost at least that amount of money per mile. And they wear out in a few years. The money under our county act is raised by bonds running 20 years at 4½ per cent. interest. The interest on these bonds is all that the present generation will have to pay as a rule. It is very light, too, when spread over a county. A taxpayer owning a house and lot worth $5,000, and having $5,000 more out at interest, told me the other day his yearly tax would not be more than a dollar or two greater on account of these roads. Although at first a croaker and opposed to them, he is now in favor of the roads.

When bonds fall due Union Co. will contain three times the number of inhabitants it has at present, and the taxable property will be three times as great. This we are safe in assuming, and more, judging the future by the past two decades.

Mr. GEORGE B. FLEECE, Superintendent of Construction of Turnpikes, has lately made an interesting report to the Turnpike Commissioners of Shelby Co., Tenn. This commission was organized under the act of 1883 providing for a similar board in each county. This law made the Chairman of the County Court ex-officio the chairman of the commission, and provided for the annual election of two other members by the County Court. The court was authorized to levy a tax of 10 cents on the $100, to be used by this commission in turnpike construction within the county.

Mr. FLEECE reports 40.2 miles of turnpike now built at a cost of $212,806.23, or a little more than $5,000 per mile, including "grading, bridging, gravel, stone, repairs, and salaries." A considerable part of the grading, however, was done by the county workhouse force, to the estimated value of $30,000. During 1889 nine miles of finished roads were added at an average cost of $4,300 per mile. As near as can be gathered from the report, these roads are made of gravel in an 8-in. layer.

Commissioner HORD, in an interview in the Nashville *American*, says that in 1888 the sum of $44,774.29 was collected from the fourteen counties nearest to Nashville, Tenn., and about the same sum was expended upon the roads. But the basis of operation seems different from that reported from Shelby Co. Commissioner HORD says that the basis of road taxes for 1889 was an average levy of 4½ days' work from each person liable to road duty, and that the property tax on country real estate alone amounted to $35,649.38. But he also says that in these fourteen counties there are 59,311 men subject to road duty; 4½ days' work estimated at 75 cts. per day upon this force would represent a tax of $207,619, which should be added to the money tax, or a total of $243,268.38. For this amount there is absurdly little to show, says Mr. HORD, and he uses the figures as an argument to prove that the labor tax, as now paid, is so much money wasted in fruitless efforts, and that it also shows that the people really do not object to being taxed roundly for roads. He estimates that the above-mentioned sum could have built 100 miles of 20 ft. wide macadamized turnpike under proper management.

Use of Natural Gas and Petroleum by Rolling Mills and Steel Works.

The *Bulletin* of the American Iron and Steel Association reports that the number of rolling mills and steel works which use natural gas wholly or in part as fuel is 104, against 96 in November, 1887, 68 in August, 1886, and 6 in September, 1884. Although the number of establishments which use natural gas has increased, it will be observed that the increase has been very slight. It may also be added that during the past year there has been much interruption to the use of natural gas at many iron and steel establishments, caused by an inadequate supply, and that some manufacturers are now contemplating a return to the use of coal entirely. Whether the cause of the inadequate supply of natural gas at some iron and steel works is due to a diminished supply from nature's storehouse or to a diversion of the popular fuel from manufacturing to domestic purposes is not clear from the published explanations which have been made, but the conclusion appears to be entirely justified that the maximum consumption of natural gas in the manufacture of iron and steel has been reached and passed.

There were 21 rolling mills and steel works using petroleum in November last, either wholly or in part, as fuel, and there may be a few others which are now using petroleum. The total number of rolling mills and steel works in the United States was 445 in November last, with 11 building; 39 new ones having been built and 27 abandoned during the previous two years.

A Manual of Railway Field Work and Laying Out of Works.

ACCORDING TO THE MOST RECENT AND APPROVED PRACTICE ON AMERICAN RAILWAYS.

BY A. M. WELLINGTON,
M. Am. Soc. C. E., M. Inst. C. E., etc.

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[*Continued from p. 90.*]

[The author will be pleased to receive typographical or other corrections, or suggestions as to form or substance, from any interested reader. All such suggestions will have full consideration.]

The curve required to make a suitable transition curve, therefore, is: A CURVE WHICH, STARTING WITH AN INFINITE RADIUS, or $D = O$, AT THE *P. C.*, *A*, Fig. 7, HAS A DEGREE AT EVERY POINT IN DIRECT PROPORTION TO THE DISTANCE FROM THE *P. C.*, UNTIL AT THE *P. C. C.*, *B*, WHERE IT CONNECTS WITH AND BECOMES TANGENT TO THE MAIN CURVE, IT IS OF THE SAME DEGREE AS THAT CURVE.

Precisely such a curve is not known to the geometrical text-books; but it approximates to the

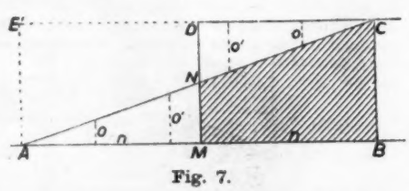

Fig. 7.

geometric curve known as the *cubic parabola* already described in § — —, in about the same manner and to about the same extent as a circular arc of small central angle approximates to a parabola—*i. e.*, it is almost identical with it. With this fact, however, we are not concerned. If the stated curve be the best for the purpose, as we have just found it to be, and if it be likewise found to be the most easily laid out, it matters not what may be the other geometric properties of the curve.

We shall now demonstrate the following geometric truths in regard to this curve, granting which it will be seen that the curve is very easily laid out, under all conditions, either by offsets or directly with the transit.

1. THE TRANSITION CURVE WILL DEFLECT EXTERIORLY FROM THE GIVEN MAIN CURVE.

Because the rate of curvature becomes continuously less than that of the simple curve, and consequently it must deflect outwardly from it.

2. IT WILL TERMINATE IN A TANGENT PARALLEL TO THE GIVEN TANGENT.

Because the same central angle is consumed.

Let Fig. 8 represent such a curve, in which *A M C* is the transition curve; *A C'* the tangent to it; *I C* the radius of the *D* curve with which it connects; *I* the central angle of the simple curve, which is thrown into the transition curve = rectangle *D M B C*, Fig. 7, and *E P* the tangent to the main curve prolonged, parallel with and at some offset $D P = O$ from the tangent *A C'* of the transition curve. Prolong the tangent *E P* to *G* and draw the tangent *C I*, cutting *E P* prolonged in *F* and *A D* prolonged in *I'*. Draw also *C C'* perpendicular to the tangent *A C'*, and cutting *E P* prolonged in *G*.

The point *A* is the *P. C.* of the transition curve, hereafter called the *P. T. C.*, or *point of transition curve*. The point *P* is the *P. C.* of the simple curve if prolonged to include the whole angle, and is always called and noted as the *P. C.*, *whether the transition curves be used or not*, to the exclusion of all other points; the point *C* is also called a *P. T. C.* or (when it is necessary to distinguish the two *P. T. C.*'s) the *P. T. C'*. Then we have further:

3. THE OFFSET $D P = O$, FIG. 8, BISECTS THE CURVE *A C* IN *M*.

Because in Fig. 7 we have

$$\left.\begin{matrix}\text{Area } D\,M\,B\,C \\ = M\,B \times B\,C\end{matrix}\right\} = \left\{\text{Area } A\,B\,C\right.$$

$$= \frac{A\,C}{2} \cdot A\,B\,C$$

whence $M\,B = \frac{1}{8} A\,B$.

[This is also the case with a cubic parabola § .....]

4. THE TRANSITION CURVE *A C*, FIG. 8, BISECTS THE OFFSET *O* IN *M*.

Because the triangles *A N M* and *D C N*, Fig. 7, are equal and similar. Hence, the angular deflec-

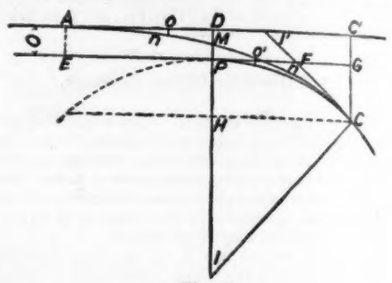

Fig. 8.

tions from the tangent to every point in the distance *A M*, and from the circular curve at every corresponding point in the equal distance *D C*, are all equal in magnitude as well as alike in distribution. Hence, necessarily, Fig. 8,

$$D\,M = M\,P = \tfrac{1}{2} O,$$

and hence the offset *D P* and transition curve *A C* bisect each other in *M*, Fig. 8.

[In a cubic parabola this is not precisely the case. We should have in Fig. 8, if the curve were a cubic parabola,

$$A\,D = D\,C' = \tfrac{1}{6} A\,C'$$

instead of $A\,M = M\,C = \tfrac{1}{6} A\,C$

and hence, although the curve bisects the offset, the effect does not precisely bisect the curve.]

5. AT ANY INTERMEDIATE POINTS *O O'*, AT EQUAL DISTANCES FROM THE CORRESPONDING *P. T. C.*'S OR FROM THE MIDDLE POINT *M*, THE OFFSETS TO THE TRANSITION CURVE FROM THE TANGENT OR FROM THE MAIN CURVE PRODUCED ARE EQUAL.

A corollary of the preceeding.

6. THE AVERAGE DEGREE OF CURVATURE BETWEEN THE *P. T. C.*, *A*, FIG. 8, AND ANY TWO INTERMEDIATE POINTS *o* and *o'* VARIES DIRECTLY AS THE DISTANCES (which let equal *m*, *m'*) TO THOSE POINTS FROM THE *P. T. C.*

Because the terminal degrees of curvature are by hypothesis directly as the distances *m* and *m'*, and at each corresponding fraction of these distances, as at ¼, ½, ¾ *m* or *m'*, the degree of curvature is likewise as *m* to *m'*.

7. THE EQUAL OFFSETS *o* OR *o'* FROM THE TANGENT OR THE MAIN CURVE PRODUCED VARY AS THE *cube* OF THE DISTANCE FROM THE *P. T. C.*

Because the offset to any circular arc of a uniform degree, *D*, from a tangent or from another curve of different *D'* degree, having a common tangent point, is by equation (— —) [given in the introductory chapter]

$$O = f\,n^2\,D$$

in which *D* = the degree of the curve if deflecting from a tangent, or the difference of degrees of curvature if two curves are deflecting from each other.

But with the transition curve, the average degree of curvature itself increases with *n*, whence we have for *D* itself

$$D = f\,n.$$

Hence, the equation of total deflection to such a curve will be of the form

$$O = f\,n^3.$$

Therefore, if we have given any central offset *O*, between main curve and tangent, which (§ - -) bisects and is bisected by the transition curve at a distance *n* from the *P. T. C.*, we have for the offset *O'* at any other point at a distance *m* from the *P. T. C.*:

$$O' = \left(\frac{m}{n}\right)^3 \frac{O}{2} \qquad (\ )$$

By this formula Table 38 is computed, giving the

transition offset at all intermediate points in terms of the total central offset O.

EXAMPLE.—If we have O. Fig. 8 = 10 ft., the offsets at the quarter points, of the curve, o' will be:

$$o' = \left(\frac{1}{2}\right)^3 \frac{O}{2} = \frac{1}{16} O = 0.625 \text{ ft.}$$

This example indicates that, even with considerable offsets, the transition curve very rapidly approximates to the tangent and main curve. At the ¼ point (quarter point of the half curve) the offset will be 1/16 of the offset at the quarter point, or 0.078 ft. At the ⅝ point (⅝ of the half curve) it will be $3^3 = 27$ times this amount, or 2.11 ft., all for a total original offset of 10 ft.

8. ANY OFFSET, O, FIG. 8, MAY BE USED WITH ANY CURVE TO CONNECT THE MAIN CURVE WITH THE TANGENT, AND THE LENGTH OF THE CURVE ONLY WILL VARY, VARYING AS $\sqrt{n}$.

Because all the preceding demonstrations of properties are independent of the particular form of the triangle $A\,B\,C$, Fig. 7. So long as the base $A\,B$, Fig. 7, is bisected in M by the side $D\,M$ of the rectangle $D\,M\,B\,C$, and hence area $D\,M\,B\,C$ = area $A\,B\,C$, the necessary conditions are satisfied. The altitude $B\,C$ being constant, as the base $A\,B$ (= length of transition curve) becomes greater, the areas of the triangles $A\,N\,M$ and $D\,B\,N$ become greater, and hence the total angle of deflection consumed by the transition curve, the latter varying directly with the half length of curve n. As the offset to any point varies directly as (angle of deflection) × (distance), we have for the central offset O at a distance n from the $P.\ T.\ C.$

$$O = f n \times n = f n^2;$$

or, if O be given, we have for the half length n:

$$n = f \sqrt{O}.$$

Definite values for this coefficient f we will now determine.

9. THE CENTRAL ANGLE I, FIG. 8, = area $A\ B\ C$, Fig. 7, IS GIVEN BY THE FORMULA:

$$\text{Sin } \tfrac{1}{2} I = \sqrt{\frac{O\,D}{3{,}820}} = .01618 \sqrt{O\,D}$$

AND THE HALF LENGTH OF THE CURVE, n, by the formula:

$$n = \frac{I}{D}$$

in which D = the degree of the main curve; O = total effect O, Fig. 8, from the main curve produced to the tangent, and n = the *half* length of the transition curve $A\,M$ or $M\,C$, Fig. 8.

In practical work, the half length of the transition curve, or length each side of the $P.\ C.$, is a more convenient unit than the entire length.

Demonstration: Since the offsets from the tangent to the transition curve vary as the cube of the distance from the $P.\ T.\ C.$, we should have in Fig. 8:

$$\text{Offset } C'C = 2^3\, D\,M = 4\,O.$$

In the cubic parabola the necessary conditions to have this equation hold is that $A\,D = D\,C'$. In the curve we are considering the necessary condition which the preceding demonstrations imply is that we shall have $A\,M = M\,C$, the difference being in any case a trifling matter for these short curves.

Then we have also:

$$G\,C = C\,C' - D\,P = 4\,O - O = 3\,O.$$

But for this distance $G\,C$, referred to the circular arc, we have:

$$G\,C = P\,C \sin \tfrac{1}{2} I$$

$$\text{and } P\,C = 2\,R \sin \tfrac{1}{2} I$$

$$\text{whence } G\,C = 2\,R \sin^2 \tfrac{1}{2} I = 3\,O.$$

Substituting for R its value in terms of D, $\frac{5730}{D}$, we have

$$3\,O = \frac{1{,}146\,O}{D} \sin^2 \tfrac{1}{2} I \qquad (\ )$$

whence

$$\sin \tfrac{1}{2} I = \sqrt{\frac{O\,D}{3{,}820}}$$

$$= \sqrt{.0002618\,O\,D}$$

or, $$\sin \tfrac{1}{2} I = .01618 \sqrt{O\,D},\ Q.\ E.\ D. \qquad (\ )$$

By this formula, Table 39 was computed, giving the total angle I consumed by a transition curve of any offset with any main curve.

Example.—A 9.5 ft. offset is to be used with a 6° curve. Then we have $\sin \frac{1}{2} I = .01618 \sqrt{9.5 \times 6} = .01618 \times 7.55 = .12216 = \sin 7° 1'$; whence $I = 14° 02' = 14.033°$.

As the values of I occuring in practice rarely exceed 20°, and are in general much less, we may in general assume with sufficient exactness, as we have already seen (§)* that

$$\sin \tfrac{1}{2} I = .0087\ I$$

and substituting this value in equation (— —) we obtain

$$.0087\ I = .01618 \sqrt{O\,D}$$

whence

$$I = \frac{.01618}{.0087} \sqrt{O\,D}$$

or

$$I = 1.86 \sqrt{O\,D} \text{ nearly} \qquad (\ )$$

Example.—A 9.5 ft. offset with a 6° curve, as above. Then $I = 1.86 \times 7.55 = 14.043° = 14°\ 2.6'$. Then the half-length, n, $\frac{14.043}{6} = 2.34$ stations (234 ft.), the same as is obtained by the more exact formula, to the nearest foot.

For the value n, the half-length of the transition curve, or the total length of the circular arc for which the transition curve is substituted, we have

$$n = \frac{I}{D}$$

or; substituting the value of I from equation ( )

$$n = \frac{1.86 \sqrt{O\,D}}{D}$$

$$\text{whence } n = 1.86 \sqrt{\frac{O}{D}} \text{ nearly.} \qquad (\ )$$

By equation (— —) Table 40 was computed, giving the half-lengths of curves for offsets varying by 1 ft. from 1 to 50 ft., inclusive, for all curves from 1° to 20°. Tables 39 and 40 are both extended far beyond the usual requirements of practice, in order that they may be applicable to metric curves as well, as also to provide for cases in which an exceptionally large offset is used for connecting different locations.

TO USE TABLE 36 FOR METRIC CURVES, *regard the first column as decimeters instead of feet*, or point off one decimal to have the column read meters. The table will then be applicable to all metric curves in which the station is 100 decimeters or 10 meters long, and in which the degree of the curve is designated by the central angle subtended by a chord of 10.0 meters, or one station. But as the degree of metric curves is usually designated by the central angle subtended by a chord of 20 meters, or two stations, thus making the value of D for any given curve twice as great, *double the value of D at the head of each column*. The table will then give the half-length of the curve in stations of 10 meters for all offsets, from 0.1 to 5.0 meters.

[These two tables will be given in full in a later issue.]

The value of I may also be determined from the table of middle-ordinates (table 14) as follows: We have in Fig. 8

$$P\,H = 3\,O = \frac{M\text{-}O,\ 2\,I}{D}$$

whence $$M\text{-}O,\ 2\,I = 3\,O\,D$$

Given, then, any desired offset O, for any D curve, entering table 14 with $3\,O\,D$, the value of $2\,I$ is determined at once.

Example.—O = 10 ft. D = 6°. Then $3\,O\,D$ = 180.0, whence we obtain, from table 14, $2\,I = 28° 48'$ and $I = 14° 24'$ or 14.4°. Referring to table 39, we find the same value. $2\,O = 9.5$, $D = 6$, as in preceding examples. Then $3\,O\,D = 171.0$, whence, from table 14, $2\,I = 28° 04'$, or $I = 14° 02'$, as before obtained.

[TO BE CONTINUED.]

Mr. F. HODGMAN writes from Climax, Mich.

In your issue of Dec. 28, 1889, is a communication from E. G. FERRISS, in regard to the $O = \frac{3}{4} n^2 D$ formula, and comments in which it is stated that the formula is original with Mr. WELLINGTON.

I wish to call your attention to the fact that it has been used many years by others than Mr. FERRISS. It is published in the Michigan Engineers Annual for 1889, in Col. MUENSCHER'S paper on "Practical Notes on Railway Location", p. 121 of the Annual, in which Col. MUENSCHER states that he had it from Prof. W. M. GILLESPIE, of Union College, more than 30 years ago. It is highly probable that Prof. GILLESPIE taught it in his classes, and thus Col. MUENSCHER was not the only one to receive it from him.

If Prof. GILLESPIE used and taught this formula, it is singular that it does not appear in any of his published writings. The formula is so simple a one, however, that it may well have been "original" with a number of different persons.

Mr. WM. GRAY writes from Tarrytown, N. Y., making a suggestion as to binding, which is precisely what the author had concluded to do:

In ENGINEERING NEWS of Nov. 9, 1889, a correspondent suggests that a field book should be bound in two volumes, text and table separately.

Now as this is a matter of taste, and some prefer one and some the other, why not compromise the matter in this way, so that each can be suited; I would suggest binding it in two volumes, the back or under side of the first volume to form a pocket in which to slide the front cover of the second, so that they could be used separately or together; in similar way to that customary for binding prayer-book and hymnals, a text book that all engineers are familiar with.

Mr. HORACE ANDREWS writes from Albany, N. Y.:

The writer cannot forbear to reply briefly to the editorial remarks appended to his communication of Jan. 23d. Regarding the proper extension and the number of places of the tables to be used in connection with Mr. WELLINGTON'S forthcoming work; he and other experienced railroad engineers are the best judges. The writer wishes to emphasize the point which he did not seem to make clear, namely for any kind of computations the tables employed should be commensurate in precision with the quantities measured. A 6-place table is sufficiently more precise than any field measurement made by the engineer to warrant its use, even when he wishes to be scrupulously exact in his numerical work.

The 6-place table (the 10th edition of Bremiker) is *more convenient* than the 7-place table, because the interpolation is much easier. The computer who uses tables only at rare intervals will not appreciate much difference in the use of good 6-and 7-place tables, but when he comes to make prolonged computations, extending over days or weeks, the 6-place tables will be found *much easier to use*. The useless ballast of figures is done away with, and the computer can soon perform all his interpolations mentally.

It is to be feared, from the confessed unacquaintance with Bremiker's 6-place tables, that the editor has been comparing *good* 7-place tables with *very poor* 6-place.

Such a comparison can only be favorable to the 7-place tables. It will not convey to your readers the important fact to be remembered, that they do not need to use superfluous decimals in their logarithmic computations any more than they need to take account of small decimals of a cubic yard in earth-work, or of mills in making out their pay vouchers.

The 6-place Bremiker, having some 150,000 to 200,000 fewer figures than the 7-place, is or course somewhat less bulky. It is stated in the preface that "these tables would have come much earlier into use if there had been any as conveniently arranged as the best tables of 7-figure logarithms, for the advantage gained by their use is by no means inconsiderable, as a computation may be performed in about two-thirds of the time, and with a great deal less labor, and with less liability to mistakes.

The writer can testify from a somewhat extended experience that the above claim is at least approximately true.

[There can be no possible objection to the use of a 6-place table *extending to* 100,000, like the 7-place table; except that for geodetic calculations it is not accurate enough, and for the run of engineering work needlessly accurate. But out of the hundreds (if not thousands) of different 6-place table, there is but the one named which extends to 100,000. All others extend to 10,000 and are what is understood ordinarily by a 6-place table. Such are an abomination from every point of view, though the most common of all in English and American works. A professional computer might well have 5-place, 6-place and 7-place logs for different uses; but it is now well settled that 5-place to 10,000, and 7-place to 100,000 are on the whole the best tables.]

THE INSTITUTION OF CIVIL ENGINEERS now numbers 5,804 in all grades of membership, an increase of 3½ per cent. in the past year.

THE CHANNEL TUNNEL between England and France is still being kept alive by its projectors. The Channel Tunnel Co. has decided to introduce in the present session of Parliament a bill to authorize the maintenance and continuance of the experimental works for a tunnel beneath the Straits of Dover.

The World's Production of Iron Ore, Coal, Pig Iron and Steel.

The following tables, taken from a paper by Mr. JAS. M. SWANK, in a government report on the mineral resources of the United States, show that the United States is now excelled only by Great Britain in the production of the above articles. The first table shows our production of iron ore and coal in 1888 as compared with the production of these commodities in European countries in the same year or in the latest year for which statistics are obtainable. The tons for the United States and Great Britain are of 2,240 lbs. The tons for the other countries are the metric "tonne" of 2,204 lbs.

	Iron Ore. Tons.	Coal. Tons.
Great Britain	14,100,000	169,935,219
United States	12,062,530	126,819,406
Germany and Luxemburg	10,604,782	91,863,511
France	2,750,000	22,951,940
Belgium	185,186	19,185,181
Austria and Hungary	2,000,000	20,779,441
Russia	1,500,000	4,650,000
Sweden	903,186	300,000
Spain	4,500,000	977,559
Italy	230,575	327,665
Other countries	2,000,000	10,000,000
Total	50,962,256	457,790,222
Percentage of the United States	23	27

In the following tables the production of pig iron and steel in 1878 is compared with the production of 1888, except that for Russia, Sweden, Spain and Italy the figures for 1886, '87, '85 and '87 are given

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* For various values of I we have:

I = sin ½ I =
1° .00873 = .00873 I
10° .08716 = .00873 I
20° .17365 = .00868 I
30° .25882 = .00863 I
} Assumed average, .0087 I.

† This notation, as previously explained, means "Middle-Ordinate of a 1° curve for a central angle of 2 I."

respectively, these being the latest years for which the statistics of these countries are obtainable:

Countries.	Production of Pig Iron.			
	1878.		1888.	
	Tons.	Per-centage	Tons.	Per-centage
Great Britain	6,381,051	45.20	7,898,634	34 05
United States	2,301,215	16.30	6,489,738	27.98
Germany and Luxemberg	2,147,641	15.21	4,258,471	18.36
France	1,417,072	10 04	1,688,976	07.28
Belgium	493,544	03.50	826,984	03,57
Austria and Hungary	434,250	03.08	761,60	03.29
Russia	409,633	02.90	541,951	02.33
Sweden	333,496	02.35	456,625	01.97
Spain	60,000	0 0.42	159,235	00.69
Italy	20,000	00.14	12,265	00.05
Other countries	120,000	00.85	100,000	00.43
Total	14,117,902	100.00	23,194,475	100.00

Countries.	Production of Steel.			
	1878.		1888.	
	Tons.	Per-centage	Tons.	Per-centage
Great Britain	1,100,000	36.41	3,405,536	35 18
United States	731,976	24.23	2,889,440	29.95
Germany and Luxemburg	570,328	18.88	1,785,354	18.45
France	281,800	0.393	525,616	05.43
Belgium	95,000	03.14	223 638	02.31
Austria and Hungary	129,478	04.29	355,038	03.67
Russia	66 593	02.20	246,000	02.54
Sweden	25,918	00.86	111,565	01.15
Spain	250	00.01	24,500	00.25
Italy	3,000	00.10	73,262	00 76
Other countries	16,750	00.55	30,000	00.31
Total	3,021,093	100.00	9,679,979	100.00

RAILWAYS.

Prospects of Railway Construction in 1890.—We intend shortly to publish the next consecutive number of our regular series of maps showing the progress and prospects of railway construction in the United States and Canada. This map will show, as correctly as can be determined at the present time, all lines of railway which have a fair prospect of being completed or placed under contract or construction during the calendar year 1890. In order that the list may be as nearly correct as possible, we would respectfully request all railway companies intending to carry on work of construction during the year, and who have not recently reported to us, to furnish us as soon as possible with such data as will make this list complete.

EAST OF CHICAGO.—Existing Roads.

Pittsburg, Akron & Western.—This company, organized some two years ago to succeed the Ohio Ry. Co., has recently let the contract for building 109 miles of new railway, and changing 56 miles of existing road to standard gauge, thus completing a line of broad gauge railway from Akron to Delphos, O., a distance of 165 miles. The contract also includes the equipment of the road. The contractors are McCracken & Semple. The new line will be practically an extension of the Pittsburg & Western Ry. across northern Ohio. John H. Semple, of Greenville, O., the Chief Engineer, now has three engineering parties in the field. The contract requires the completion of the line during the present year.

Scioto Valley & New England.—The sale of the Scioto Valley R. R. has been confirmed, and the company was reorganized under the above name with a capital stock of $5,000,000. The following officers were chosen: President, John Byrne, New York; Vice-President, C. Weidenfeld, New York; Treasurer, L. C. Newsom, Columbus, O.; Secretary, J. W. Whitney, New York; Assistant, C. O. Hunter, Columbus; General Counsel, F. Sullivan Smith, New York.

Napanee, Tamworth & Quebec.—This company seeks power from the Dominion Government to extend its line westerly to Sault Ste. Marie, with a branch to Sudbury; also, to extend its line easterly to the St. Lawrence and to Ottawa; also, for power to build branches from its line to any iron or other mines in the counties of Leeds, Lanark, Hastings, Frontenac, Peterboro, Victoria, and Nipissing district; also, for power to change the name of the company, and for power to construct a bridge for railway purposes across the St. Lawrence River, from some point within the County of Leeds, between Sir William Island and Rockport, to some point in the State of New York.

Pittsburg, McKeesport & Youghiogheny.—The McKeesport & Belle Vernon R. R. has been merged with this road, and will hereafter be operated under the same management.

Philadelphia & Reading.—The railroad committee of the Philadelphia City Council have reported in favor of extending the P. & R. Terminal R. R. from Arch St. to Market St.

Pennsylvania.—Work on the Waverly & New York Bay R. R., which is being built from Waverly, N. J., to New York Bay, for the purpose of affording this company a through freight line to New York City, has been suspended on account of a dispute about a grade crossing with the Central R. R. of New Jersey. A considerable amount of grading has been done.—Rapid progress is being made on the other short cut for passenger traffic which is being built to avoid the city of Newark, N. J., and thus save the delay in passing through the city.

Wabash.—The engineers of this company are reported to be surveying for a line to run from a point west of Toledo, O., through Auburn, Garrett, Avilla and Albion to Chicago, Ill.

Old Colony.—A force of about 700 men is now at work on the branch from North Attleboro to Wrentham, Mass. a distance of 11 miles. The work has been quite heavy. The roadbed has been built for double track. It is expected to have the line completed early in the summer.

Irondale, Bancroft & Ottawa.—We have received the following information from Chas. J. Pusey, of Ironside, Ont., Vice-President and General Manager:

About 50 miles of this road, which is to be 225 miles long, has been located from Bancroft to Irondale. The work is generally light. The work will be done by the company and will commence in the spring. The principal business of the road will be iron ore and lumber. Henry S. Howland is President, and G. W. Ranney is Chief Engineer.

Michigan Central.—J. W. Hawks, of Detroit, Mich., Chief Engineer, writes us as follows concerning the Bay City Belt Line R. R.:

The road is a branch of the Detroit & Bay City R. R., running from the Water St. track at a point near Twenty-sixth St. in Bay City eastward to a connection with the main line of the Michigan Central R. R., a distance of 3.1 miles. The line is almost straight and nearly level. The object of the line is to facilitate the transfer of freight and to afford a connection with the various manufacturing establishments along the route. The road was built by the company during the past year. D. J. Casey, of Bay City, was the engineer in charge of construction.

Pennsylvania, Lehigh & Eastern.—Samuel F. Pierson, of 111 Broadway, New York City, writes us that this is the reorganization of the Lehigh & Eastern Ry. Co., chartered by a special act of the assembly in 1868. The franchises of the Lehigh & Eastern Ry. Co. were acquired by the present company by purchase in May, 1889. The road is projected to run from Port Jervis, N. Y., to Tomhicken, Pa., a distance of 100 miles. The surveys have been completed and 10 miles of the road west from Matamoras, Pa., opposite Port Jervis, has been graded. The road follows the Delaware River from Port Jervis to near Stroudsburg, and from that place runs directly west to Tomhicken, penetrating the heart of the anthracite coal region. The work will be quite heavy; maximum grade 50 ft. per mile. The principal business of the road will be in coal, timber, and general merchandise. S. N. Haight, of 111 Broadway, New York City, is Chief Engineer.

Northern Central.—The Union R. R. Co. has completed its arrangements for raising its tracks above the street grades in Northern Baltimore. The Union is a toll railway and forms the connecting link between the Baltimore & Potomac R. R., at Union Station, and the Philadelphia, Wilmington & Baltimore R. R., at Bayview Junction. Its bed lies in a tunnel until it reaches a point near Bond street on the east, and the contemplated improvements are only to apply to that part of it between Broadway and Bayview. They include the doubling of the road's present facilities by the building of two additional tracks, and raising all the rails upon bridges until they are about 16 ft. above the level of the streets across which they are now stretched. The bed of the road will be elevated upon these bridges and earthen embankments, with retaining walls of stone, which will be adapted to suit the new grade. This work will require the erection of 11 wrought iron girder bridges supported on abutments of masonry. It is estimated that the improvement will cost about $500,000 and will take two years to complete.

Projects and Surveys.

Schenectady & Albany.—J. W. Van Valkenburgh, of 3 Park Place, Albany, N. Y., has furnished us with the following information:

This road is only a short link in a line of railway, which is projected to run from New York City via Albany and Ogdensburg, N. Y., to Ottawa, Ont. The road is to run from Albany to Schenectady, N. Y., a distance of 15 miles. Surveys are now in progress. The officers are Verplanck Colvin, President; James Brown, Chief Engineer, and Wm. L. M Phelps, Secretary and Treasurer; all of Albany, N. Y.

The remainder of the line from New York to Ottawa will be built under different charters. The portion from Schenectady to Ogdensburg will be built by the New York Northern R. R. Co., chartered in 1866. The surveys have been made, and maps, profiles and estimates completed. The charter gives the company until Dec. 31, 1895, to build the line. The route is through a region rich in timber and minerals and containing a large number of small lakes and streams. The New York & Albany R. R. Co. was chartered to build the line from Albany to New York City. Two routes were located along the west bank of the Hudson River, and plans and estimates have been made. A portion of the route has since been taken by the West Shore R. R., but the new company expects no difficulty in obtaining another route. It is intended to consolidate the three companies under the name of the New York, Ottawa & Northwestern Ry. Co.

Thousand Islands Bridge & Ry. Co.—In addition to the bridge across the St. Lawrence River, noted in our bridge columns in our last issue, this company proposes to build short lines of railway to connect the bridge with the Grand Trunk Ry. in Canada and with lines of New York railways on the American side of the river.

Kingston, Smith's Falls & Ottawa.—A press dispatch states that the capital necessary to construct this line has been secured, and that work will soon begin. The road is projected to run from Kingston to Ottawa, Ont., about 100 miles. D. A. Givens and Geo. A. Kirkpatrick, of Kingston, Ont., are among the incorporators.

Manitoulin & North Shore.—This company proposes to build a line of railway from Little Current to Nairn, Ont., a distance of about 28 miles. Surveys are now in progress.

Tuckahoe & Cape May.—Chartered in New Jersey to build a line of railway from Tuckahoe to Cape May, N. J., a distance of 25 miles.

Plymouth & Bournedale.—Surveys are in progress for this Massachusetts road, described in our issue of Jan. 25. Henry A. Hancox, of Hudson, Mass., is Chief Engineer.

Howellville, Coudersport & Westport.—Chartered to build a railway from Westport, Clinton County, to a point in Potter County, known as Hou Buck. N. J. Peck, of Coudersport, Pa., is President.

Mt. Moosilauke.—At a meeting of the directors recently held at Concord, N. H., it was decided to make a new survey for this road with a view of securing a grade capable of being overcome by friction. The two surveys already made were for a rack railway. It is thought that a friction grade can be secured. John H. Pearson, of Concord, is President.

Escanaba, Iron Mountain & Western.—A railway company by this name has been incorporated in Michigan.

SOUTHERN.—Existing Roads.

Norfolk & Western.—This company is marketing an issue of $5,000,000 of bonds, secured by mortgage upon the company's terminals at Lambert's Point and Norfolk, Va. In its statement the company says:

To provide funds for an extension of its system northwest to the Ohio River at Ironton, about 195 miles, southward to the North Carolina State line, about 70 miles, as well as to make provision for double tracking, for future improvements and additions, and for the refunding of its existing bonded indebtedness, the company has created a mortgage to secure an issue of bonds limited to $15,000,000, and covering the entire system; $10,000,000 of the bonds are authorized for the construction of the extension to the Ohio River and to the North Carolina State line and for sundry requirements; $10,000,000 are set apart for double tracking, improvements, and branches; $25,000,000 can be used only to take up former issues, either at maturity or by earlier purchase.

The present issue is a part of the first $10,000,000 to be issued for the construction of the Ohio and North Carolina extensions.

Georgia, Southern & Florida.—J. S. McTighe & Co., of Memphis, Tenn., are advertising for bids for the construction of 50 miles of the Macon & Birmingham R.R.

Baltimore & Ohio.—It is stated that this company will extend the Grafton & Greenbriar R.R., running from Grafton to Belington, W. Va., to Elkins, W. Va., a distance of 12 miles. The route will be through a region rich in iron and coal.

Columbus Southern.—Tracklaying has now been completed from Columbus, Ga., south 61 miles, and is now being pushed at the rate of one mile per day. The grading has been completed to Albany, Ga., with the exception of a short distance near Dawson, Ga. It is expected that the road will be in operation by March 15.

Atlantic Coast Line.—Work has been commenced on the short line of railway from Thunderbolt, Ga., to Isle of Hope.

Richmond, Nicholasville, Irvine & Beattyville.—Surveys are reported in progress for an extension of this road from Beattyville to Cumberland Gap, Ky.

Knoxville Southern.—Geo. R. Eager, President of this road, is quoted as saying that work was making very satisfactory progress and that the grading would probably be completed by March 15. Track laying on the Tennessee end of the line is being pushed. Enough rails are on the ground to lay 30 miles of track. The bridge across the Hiawassee River will be completed by April 1, and it is expected that the entire line will be in operation by June. New track has been laid on the Marietta & North Georgia R. R. from Atlanta to the Tennessee State line. Contracts will soon be let for the bridge across the Tennessee River at Knoxville.

Louisville & Nashville.—Work, it is stated, will soon begin on the line from Clarksville to Dickson, Tenn. Surveyors are to be put into the field at once and the route located, so that construction can be commenced during this month. President Smith is quoted as saying that this company would take charge of the Anniston & Atlantic and the Anniston & Cincinnati railways very soon, and that work on the extension from Sylacauga to Longview would begin at an early date. The Anniston & Atlantic R. R. will have to be changed to standard gauge.

Union Point & White Plains.—This company is considering the building of an extension from White Plains to Tennile, Ga., a distance of about 40 miles.

South Mississippi.—R. H. Thompson, of Brookhaven, Miss., sends us the following:

The road is projected to run from Meridian to Natchez, Miss., a distance of 180 miles. The preliminary surveys have been made by Maj. Belton Mickle, of Holly Springs, Miss., and 73¼ miles of road from Brookhaven, east, have been built. This is now the property of the Illinois Central R. R. The route is through a rolling country affording light grades and curves. The principal business of the road will be in lumber, agricultural products and general merchandise. Capt. J. E. Hoskins, of Brookhaven, is interested.

Western Maryland.—President John M. Hood, of this company, has sent us the following information, concerning the Potomac Valley R. R. Co., whose incorporation was noted in our issue of Jan. 25:

The road is to run from Williamsport, Md., to Cherry Run, W. Va., a distance of 14 miles. The preliminary surveys have been completed and location begun. The work will be moderately heavy; maximum grade 40 ft. per mile and maximum curve 5°. There will be iron bridges across the Conococheague Creek, at Williamsport and the Potomac River, at Cherry Run. The company has just been organized. No right of way or other local aid has been secured, and no time has been fixed for letting the contracts. The company was chartered Jan. 14, 1890.

Covington & Macon.—Good progress is being made with the work between Machen and Eatonton, Ga. The grading is completed for nearly half of the distance, and 1¼ miles of track have been laid. It is expected that the grading will be completed the entire distance in about a month, and as all the rails are on hand and the cross-ties are ready, that the line will be completed by April 1. L. W. Roberts, of Macon, Ga., is Chief Engineer.

Projects and Surveys.

Louisville Belt.—A bill has been introduced into the Kentucky Legislature incorporating this company to build a belt line transfer railway around the city of Louisville, Ky. Among the incorporators are: Jno. J. Barrett, F. F. Lutz, J. N. Struck and others of Louisville.

Rosedale & Mississippi Central.—A bill has been introduced into the Mississippi Legislature to incorporate this company with power to construct a line of railway from Rosedale to Bogue Phalia.

Mobile, Jackson & Kansas City.—The citizens of Mobile, Ala., have subscribed $175,000 of the $250,000 asked by this company in aid of its proposed road.

Florida, Midland & Gulf.—A meeting of the directors of this road will be held Feb. 8, to elect officers, and complete the organization of the Georgia & Florida Construction Co., which is to build the road. It is stated that work will commence at once. The road is projected to run from Valdusta, Ga. to Deadman's Bay, Fla., a distance of about 90 miles. W. B Thomas, of Tennille, Ga., is interested.

Chattanooga, Gadsden & Birmingham.—It is announced that a New York construction company has made this company a proposition to construct the line from Gadsden to Leeds, Ala., on condition that the City of Gadsden subscribes $25,000 in aid of the enterprise. R. O. Randall, of Gadsden, is interested.

Kiniconnick & Freestone.—A bill to incorporate a railroad company by this name has been introduced into the Kentucky State Legislature.

NORTHWEST.—Existing Roads.

Duluth & Winnipeg.—This company has just filed a mortgage of $7,000,000, made to the Guarantee Loan and Trust Co., of Philadelphia. The proceeds are to be used in completing the line from its present terminus to the International boundary, and in purchasing equipment for the road. Surveys are now in progress for the extension, and work on construction is expected to begin as soon as the spring opens. W. H. Knowlton, of Cloquet, Minn., is Chief Engineer.

Canadian Pacific.—This company has a corps of engineers at work making surveys for a line of railway to run from the main line near Fire Steel River, in Ontario, crossing the Atikon iron range, a distance of about 30 miles. The road if built would open up a large number of fine iron mines. It is stated that the line will be built if a practicable route can be found.

Projects and Surveys.

Winnipeg & Northern Pacific.—The old project of building a railway from Winnipeg, Man., west to the Pacific Coast, has been revived. New articles of incorporation have been secured from the Canadian government, and applications are now being made for land grants of large extent. The route of the road will be northeast from Winnipeg through the Rocky and Selkirk mountains to a point on the coast, where connections will be made with a line of steamers running to China, Japan and Australia. The promotors of the enterprise are American, Canadian, and English capitalists, and it is stated that the money necessary to build the line is at hand, and that construction will commence as soon as the land grants are received. This same enterprise was being agitated in 1887, and was fully described in our issue o Dec. 10 of that year.

Burlington, Stillwater & St. Paul.—Incorporated in Wisconsin to build a line of railway from St. Croix, Wis., through the counties of St. Croix, Dunn, Pepin, and Pierce to Pepin, a distance of 125 miles. Among the incorporators are: John Q. Swanson, William Kenneman, Adolph Dreschler, and G. Holcombe. The principal offices of the company will be at Houlton, Wis.

Port Edwards, Centralia & Northern.—At a recent meeting of the directors of this company, whose incorporation was noticed in our last issue, the following officers were elected: President, T. E. Nash; Secretary, S. J. Wood, and Treasurer, John Edwards. Arrangements were also made for commencing the surveys for the line, and for carrying out all preliminary work, looking forward to the early commencement of construction.

Rapid City, Harney Peak & Southwestern.—A press dispatch states that the final location of this line has been completed, and that work will begin soon and the road be completed this year. The road is to run from Harney City, So. Dak., to the Black Hills tin districts. Harney City has voted $40,000 in aid of the enterprise.

Sellwood & Milwaukee.—A railway company by this name has been incorporated in Wisconsin.

Winnipeg & Duluth.—This company will apply to the Provincial Government for a charter authorizing it to construct a railway from Winnipeg, Minn., to a point on the International boundary, near the Lake of the Woods.

Midland Pacific.—At a meeting of the stockholders recently held, the following officers were elected: S. L. Tate, President; Delos Beech, of Maine, Secretary; Geo. L. Shoup, of Boise City, Idaho, Vice-President, and Joseph Simpson, of Sioux City, Ia., Treasurer. The road is projected to run from Sioux Falls, So. Dak., to Seattle Wash.

SOUTHWEST.—Existing Roads.

Mississippi & Little Rock.—S. L. Harr, of Fairmount, Ark., has furnished us with the following information concerning this enterprise:

The road is to run from Duncan, a point on the Arkansas Midland R. R. about 6 miles east of the White River, west to Little Rock, Ark., a distance of 61 miles. The route is through a level country, a portion of which is heavily timbered and the whole very fertile. There will be two large bridges crossing the White and Arkansas rivers. The surveys have been completed, and the contract for construction was let to R. W. Werthen, of Little Rock, Ark., Jan. 16. About 20 miles of the line are now graded ready for the rails. Nearly 100 men are now at work, and it is expected that tracklaying will begin within 30 days. The principal business of the road will be in lumber, cotton, hay and general farm produce. The company was incorporated Jan. 10, 1890. Jas. A. Martin is the engineer in charge of construction.

Topeka, Westmoreland & Marysville.—It is announced that the money necessary to complete this road has been secured and that construction will commence early in the spring. The road is projected to run from Topeka, Kan., via Westmoreland and Marysville, to Odell, Neb., a distance of 110 miles. Five and one-half miles of the line have been completed. A. B. Pomeroy is President and Robert Giles, of North Topeka, Kan., is Chief Engineer.

Texarkana Northern.—The State of Texas has authorized this company to issue bonds to the amount of $4,000,000. The proceeds are to be used in building the line to Fort Smith, Ark. One mile from Texarkana, Tex., north was completed last year and about 15 miles of the road was graded. J. E. Dougherty, of Texarkana, Tex., is Chief Engineer.

St. Louis, Iron Mountain & Southern.—A press dispatch states that surveys are in progress for an extension of the Jackson branch of this road from Jackson, Mo., to some point on the Mississippi River.

Texas & Atlantic.—This company has been chartered in Texas by J. H. Bemis, of Jefferson, Tex., Ed. Rand, of Dallas, Tex., and J. H. Smelser, of Texarkana, Tex., and others. The principal offices will be at Texarkana. The object of the company is to connect and consolidate a number of lumber roads and to connect these lines with the St. Louis, Arkansas & Texas and the Texas & Pacific railways.

Projects and Surveys.

Anson & Abilene.—H. A. McEachin, of Anson, Tex., Secretary, writes us that this Texas road will be 28 miles long. The work will be very light. The principal business will be in agricultural produce, stock, lumber, etc. The road will be graded by local subscriptions, and the company is looking for aid to iron and equip the line. Martin Duvall is President.

Gulf, Sabine & Kansas City.—This company has been incorporated in Louisiana to build a line of railway from the Arkansas State line to the Gulf of Mexico. The City of Shreveport has voted a 5-mill tax in aid of the enterprise. Among the incorporators are: D. P. Doak, of Kansas City, Mo., Joel Haxden, of Boston, Mass., and Thos. Doak, of Ft. Smith, Ark.

Henrietta, Seymour & Pacific.—This company has been organized in Texas to build a line of railway from Henrietta to Seymour, Tex. The old grade of the Missouri, Kansas & Texas R. R. will be used for a portion of the distance. The directors are: Francis Fuller, of Galesburg, Ill; S. Davidson, J. N. Graves, A. D. Goodenough, W. B. Wersham, of Henrietta, Tex.; J. N. Leper, of Farmington, Ill., and C. E. Grant, of Galesburg, Ill.

ROCKY MT. AND PACIFIC.—Existing Roads.

Seattle & Northern.—F. A. Hill, of Anacortes, Wash., Chief Engineer, sends us the following data concerning this enterprise:

The road is to run from Anacortes east along the Skagit River, a distance of 30 miles. The route is along the river bottoms, affording very light work; maximum grade, 0.5 per cent. All of the right of way has been secured, and 2,000 acres of land on Fidalgo Island obtained. The entire line has been located, and 23 miles of the grading is now completed. It is expected that tracklaying will begin about March 1, and the road completed and opened for traffic by Aug. 1, 1890. The principal business of the road will be in coal, timber and grain.

Union Pacific.—Sidney Dillon, a director of this company, is quoted as saying that while the Union Pacific R. R. may at some time build to the Pacific Coast it will feel its way there, rather then force competition with the Central and Southern Pacific roads by rapid construction not warranted by natural conditions of business. The line will soon be extended to Pioche, near the border of Utah and Nevada. Contracts for the construction to that point have been made and part of the grading has been done. Beyond Pioche the Union Pacific directors have not decided what they will do. They will rest at that point for the present, and then decide in what direction further extension will be made. Mr. Dillon denies that contracts have been made for construction beyond that point.

Northern Pacific.—A press dispatch from Tacoma, Wash., states that this compay will construct during the present year a railway from Seattle or a point on the Puget Sound Shore R. R., recently purchased, in a northerly direction to the International boundary, with branches to Bellingham Bay and Ship Harbor. The location of the line will be commenced at once, and construction will begin as soon as the weather permits in the spring.

Projects and Surveys.

Salmon Bay Ry. and Development Co.—This company has been incorporated in Washington to build a railway from a point near Seattle to and across Salmon Bay to some point near the head of Lake Washington with the privilege of extending it to the summit of the Cascade Mountains. The incorporators are: Thos. Burke, John Lauvy, and D. H. Gilman, of Seattle, Wash.

Portland, Lower Columbia & Eastern Washington.—It is announced that work will soon commence on this road, which is projected to run from Portland, Ore., to North Yakima, Wash. The route is through a mountainous country.

Mt. Helena Gravity.—There is some talk of building a gravity road on Mt. Helena, Mont. The mountain is about 1,300 ft. above the city of Helena, Mont., which is situated at its base, and 5,506 ft. above the sea-level.

RAPID TRANSIT.

Cable Railway.—The Newark & South Orange St. Ry., of South Orange, N. J., will be purchased by a syndicate which proposes to convert it to a cable line. The line is 8 miles long.

Elevated Railway.—At Boston, Mass., Wm. B. Mack has applied for a charter for a company to build elevated railways on the Mack system.

Street Railways.—The North Third Ave. & Fleetwood Park Ry. Co. has been incorporated to build a line in New York 2 miles long. President, Matthew B. Wynkoop. Capital stock, $100,000.

In Brooklyn, N. Y., a plan for a depressed railway in an open cut, on Atlantic Ave., instead of an elevated railway, has been presented to the Ninth Rapid Transit Commission by Wm. H. Hornum, C. E. The cost is estimated at $650,000 per mile.

Electric Railways.—The Augusta, Hallowell & Gardiner Electric Ry. Co., of Augusta, Me., will build its line this spring. The road will be about 3 miles long.

The Pawtucket Tramway Co., of Pawtuckot, R. I., is to be organized to build an electric line to Providence.

The Crescent City Ry. Co., of New Orleans, La., has been authorized to operate its cars by storage batteries.

An electric railway between East Saginaw and West Bay City, Mich., is projected. It will be about 13 miles long.

The Rockford Electric Ry. Co., of Rockford, Ill., has been incorporated by H. H. Robinson, Geo. M. Blake, and Frederick Haines. Capital stock, $150,000.

The Fort Clark St. Ry., at Peoria, Ill., is to be operated by electricity. For particulars address Capt. John Hall.

The Colfax Ave. St. Ry. Co., of Denver, Col., has been granted a franchise for an electric railway on York Ave.

The Fairhaven Electric Ry. Co., of Fairhaven, Wash., has been incorported by Nelson Bennett, H. S. Thompson and C. X. Larrabee. Capital stock, $250,000. It is proposed to build several suburban lines.

The Houston City St. Ry. Co., of Houston, Tex., has decided to extend its lines and adopt electric traction.

At Great Falls, Mont., the preliminary work is being done on the electric railway. The line is to be opened by June.

HIGHWAYS.

Indiana.—On Jan. 28, an election was held in Walker, Rushville, Jackson and Center townships, in Rush Co., Ind., to decide whether certain toll roads should be purchased or not. Walker, Rushville and Jackson townships voted in favor of the purchase and Center against, but the majorities in the other townships were sufficient to overcome this, and 33.78 miles of free gravel road will be added to the system of the county at a cost of $17,902.29.

This item was sent in by Mr. W. H. Downey, Surveyor, Rushville, Ind., who writes as follows: "I am a constant reader of your valuable paper, and I saw an item in the same of the last 'pike election' held in this county, Dec. 3, 1889. Supposing you would be glad to receive any items of the same kind I inclose an item of the election of Jan. 28." In view of the growing importance of the highway question we shall be very glad to receive any information of this kind.

Ohio.—At an adjourned county pike meeting at Steubenville, on Jan. 29, the committee reported in favor of a system of pikes throughout the county of 116 miles. This, as laid out, would bring every farm in the county within four miles of a pike or railroad. It would be secured upon the leases of a two-mill tax levy upon the $19,000,000 of Jefferson Co.'s taxable property, could be built within six years and the entire indebtedness liquidated before 18 years. The committee's report was received, and some amendments were offered. Discussion developed a strong opposition from the back country districts. It is likely that Steubenville City and the townships of Cross Creek, Salem and Island Creek, which represent $10,000,000 out of the $19,000,000, will endeavor to unite, leaving the back districts to secede if they desire, and build a system of 44 miles themselves.

Maryland.—The Sykesville Road Improvement Association has within the past two months expended $500 in highway improvements about Sykesville. This sum has been subscribed by residents of the neighborhood. It is stated that Postmaster Frank Brown, of Baltimore, whose country seat is near Sykesville, will contribute $1,500 toward continuing the improvements to the Liberty turnpike.

New York.—One of the principal intentions in creating the public improvement commission of Troy, N. Y., was to secure the improvement of the highways leading into the city. It has been found that the law empowering the public improvement commission, while specifying the improvement of the highways as one of the matters under the control of the commission, does not give authority for the city paying half the expense. Thus the commission's powers with reference to the highways are practically nullified. Amendments to the act are about to be presented to the State Legislature, and the principal amendment will provide that the city may pay half the expense of improving the highways, as it is now allowed to do in paving streets or building sewers.

WATER-WORKS.

NEW ENGLAND.

Manchester, N. H.—A petition has been presented to the City Council asking for the construction of a high-service reservoir on Wilson Hill.

Lowell, Mass.—The city will ask the Legislature for permission to negotiate a loan of $1,000,000, to refund the water debt.

Braintree, Mass.—At a special town meeting, held to dispose of the legal difficulties now pending between the city and the Braintree Water Supply Co., the following resolution was adopted:

That it is the sense of this meeting that all matters in dispute be speedily settled, not only to stop legal expenses consistent with equity and justice, but that the town may be enabled to secure possession of the works, operate and manage the same, make such extension of the system of pipes as may be required by the necessities of the people, and, in view of the recent action of the mill owners in dispossessing of the water rights and privileges, we favor such additional legislation as may be necessary to confirm to the town any and all rights which may have been acquired by said water company, by purchase or otherise, so that the town may be fully protected, and may have the full enjoyment and benefits of efficient water supply for domestic, manufacturing and fire purposes.

Lynn, Mass.—The Mayor will petition the Legislature for authority to issue bonds for $150,000, the proceeds to be used in laying new mains and increasing the source of supply.

New Bedford, Mass.—About $12,000 will be appropriated to the Water Department this year.

Fall River, Mass.—In the estimates for the annual appropriations, $5,000 is requested for extensions.

Providence, R. I.—A resolution has been adopted authorizing the Commissioner of Public Works to purchase cast-iron water pipes and special castings.

MIDDLE.

Babylon, Amityville & Breslau, N. Y.—A home company, with a capital stock of $75,000, will probably be organized to supply these towns with water. The proposed plan is to secure the interest of 150 of the best citizens, 50 in each town, raise $20,000 in cash, and issue $55,000 of bonds. A canvassing committee has been appointed. Information can be given by Mr. Edward Sammiss. The Lockwood proposition is also under consideration.

Caldwell, N. Y. (P. O. at Lake George).—Articles of incorporation of the Lake George Water-Works Co. have been filed by James Ferguson, A. H. Fennel, E. L. Seelye, Daniel Ferguson and others. The capital stock is $15,000.

New York, N. Y.—The following bids have been received by the Aqueduct Commissioners for building a masonry and earthwork dam for Reservoir M, on the Titicus River, near Purdy's Station. The specifications include a gatehouse and other required structures. Washburn, Shaler & Washburn, $933,065; J. C. Rodgers, $991,440; M. S. Coleman, $998,845; Breuchaud, Pennell & Co., $1,031,240; O'Brien & Clark, $1,055,065; F. Thilemann, $1,061,030; Smith & Brown, $1,064,810; D. R. Paige & Co., $1,124,450; Charles Peterson, $1,140,650; Clinton Stephens, $1,168,060; Charles H. Raynor, $1,205,025. The engineers' estimate was placed at $1,151,000. The dam is to be 100 ft. high by 1,200 ft. long, and will impound 6,000,000,000 galls. of water. The bids were referred to Chief Engineer Fteley.

Brooklyn, N. Y.—The contract for section 5 of the new aqueduct has been awarded to M. T. Davidson at $76,400.

Scottdale, Pa.—The city has received a proposition from a company to furnish the town with water for $2,200 per year. Estimated cost, $100,000.

Williamsport, Pa.—M. H. Bloom, Secretary of the water company, writes: "We will construct two new reservoirs this spring, some distance above our present site, which will give about 50 ft. additional head. Will be open for bids soon."

Philadelphia, Pa.—A proposition has been received from the United States Water Supply Co. offering to furnish the city, by means of the Syphon Gang Well system, a daily supply of 150,000,000 galls. of potable water for $4,000,000, the city to own the plant. The company also offers to lease the plant at a yearly rental of $250,000 for a term of not less than 20 years. The Schuylkill Water Co.'s scheme is still under consideration.

Du Bois, Pa.—We have received the following information from H. S. MacMinn, Engineer for the new works:

The gravity system of works, constructed by the U. S. Water Supply Co., of Bay City, Mich., was officially tested on Jan 15. Six springs, located in Boon's Mountain, furnish the present supply. They are connected by a 4-in. pipe, which connects with a 6-in. pipe, and this in turn with an 8-in. pipe, which conveys the water to a reservoir of 2,000,000 galls. capacity. Two additional springs will probably be connected in the spring.

A 12-in. main conveys water from the reservoir to the town. There are 3¼ miles of 10 to 4 in. distribution mains, and 51 hydrants, for which the town pays $1,785 per year. Engineer, H. S. McMinn; Superintendent of Construction, C. J. Shuttleworth, of Springville, N. Y.

SOUTHERN.

Roanoke, Va.—City Engineer Dunlap has made surveys for the location of water mains leading to the Allegheny Institute and that part of the city.

Richmond, Va.—The estimated expense of the water department for 1890 is $82,820.27. This includes putting down a 16-in. pipe along Lombardy St., from Main to Broad, which is intended as a feeder for pipes in the West End and repairing the canal banks near the Five-Mile locks. The walls will be raised, the masonry strengthened and an overflow put in to carry off the surplus water.

Reidsville, N. C.—It is reported that the Reidsville Cotton Mills contemplate establishing a system of works in its mill and is having estimates prepared.

Elizabeth City, N. C.—Address the City Clerk for information regarding the projected works. It is reported that propositions will be received for establishing a system.

Griffin, Ga.—Mayor Stewart is in favor of having works established.

West End, Ga.—The question of issuing $50,000 of water bonds will be voted upon on Feb. 25. J. W. Nelms is Mayor.

Atlanta, Ga.—At a recent meeting of the Commissioners, the Water Committee, and the Common Council, a motion to build a new system of works was carried. The third plan proposed in Consulting Engineer Rudolph Herring's report is the one adopted. A report upon this plan has been made by City Engineer Clayton. Water will be taken from the Chattahoochee River, at Randall's Shoal. The total estimated cost is $467,475. A report since submitted by A. L. Koutz, Chairman, Committee of Water-Works, has been adopted. By it, authority is given to advertise for bids for constructing the new works.

Tallahassee, Fla.—The company has decided to bring water from Houstoun's Springs, about one mile east of the city. The reservoir is now being constructed.

Natchez, Miss.—Notwithstanding experts have reported in favor of artesian well water, the Board of Aldermen demand that the supply shall be furnished from the Mississippi River. If their plan is carried out filters and settling basins will be necessary. The Natchez Water & Sewer Co. has the contract.

Pass Christian, Miss.—The Artesian Well Co., which is to supply the East End, has struck a copious flow of pure water.

Trenton, Tenn.—The question of constructing works is being discussed.

Stanford, Ky.—Engineer H. A. Evans writes: "We have at present only gotten so far as mincing the matter. I have been at work getting data for a rough estimate of cost, but that is all." The proposed plan is to pump water from three large springs to a stand-pipe.

Harrodsburg, Danville & Richmond, Ky.—H. A. Evans, of Stanford, Ky., informs us that works are projected in these places.

Princeton, Ky.—It is reported that a stock company, with a capital of $25,000, has been organized to build works.

NORTH CENTRAL.

Marysville, O.—A vote will be taken on April 1 to decide the question of building works.

Fostoria, O.—Consulting Engineer J. M. Howells, of Chicago, Ill., informs us that the new works will be completed in October. Also that the following contracts have been awarded:

Pumping machinery: Gordon Steam Pump Co., Hamilton, O., $7,950. Boilers: Mansfield, (O.), Machine Works, $2,744.19. Pipe: Lake Shore Foundry, Cleveland O., $27.10 per ton. Specials: Rockwell Machine & Car Co., Sandusky, O., $43.50 per ton. Trenching and pipe-laying: J. J. Rumsey, Findlay, O. Stand pipe: Porter, Jackson & Co., South Chicago, Ill., $7,700. Valves: Rensselaer Mfg. Co., Troy, N. Y., 10 in., $24.60; 8-in., $17.90; 6-in., $11.75; 4-in., $7.50. Hydrants: R. D. Wood & Co., Philadelphia, Pa., 2-way, $25 each; 4-way, $27 each. Valve boxes: Bingham & Taylor, Buffalo, N. Y., 161 boxes, $535.95.

Charlotte, Mich.—A special election will be held on Feb. 17 to vote upon the question of issuing $25,000 of bonds for extending the water works and making other improvements.

Peoria, Ill.—The water company is preparing to build a water tower on Bourland St.

Oconto, Wis.—E. Scofield and Higgins Bros. have made a proposition to the city to construct and maintain a system of works for a period of 30 years. The council has taken the matter under advisement. The estimated cost of the proposed system is $250,000.

Kilbourne City, Wis.—G. M. Markell, Engineer of the new works, informs us that they will be completed about April 1. Water is pumped from a well to two wooden tanks. Estimated cost, $6,000.

NORTHWESTERN.

Davenport, Ia.—The company will expend $10,000 in extending its mains.

Albert Lea, Minn.—The City Council has passed the ordinance and franchise asked for by E. T. Sykes & Co., of Minneapolis, for putting in a system of works. The contract provides for 5 miles of mains, the city to have hydrants for fire protection, paying $3,800 per year. The contract is to continue 30 years, the city to have the option of purchasing them every 5 years, arbitrators fixing the value.

Helena, Kan.—Address the City Clerk for information regarding projected works.

Smith Centre, Kan.—The new works have been completed.

Hutchinson, Kan.—A good flow of water is being obtained from the artesian well at a depth of 204 ft. Hydrants for fire protection and a public fountain will probably be wanted.

Osage City, Kan.—Works are projected. Prospecting is being made for a source of supply.

Topeka, Kan.—Owing to increased demands for a large amount of extensions and improvements, the water company has asked for the passage of an ordinance permitting them to reorganize the present company and issue a blanket mortgage to cover all of their property, and in this way secure funds with which to carry on the work. They ask that all their present rights and privileges shall be reserved, as well as the restrictions, limitations and rights of the city. Several hundred thousand dollars will be expended in new work if the plan is carried.

Minden, Neb.—The city has awarded a contract for constructing works.

Laramie, Wyo.—The City Council has appointed a committee to confer with the Union Pacific R. R. officials at Omaha concerning the water supply. The springs from which the water is obtained are controlled by the railroad, and if the city can secure their control an extensive water system will be put in.

SOUTHWESTERN.

Lamar, Mo.—The City Council has passed an ordinance inviting bids for the construction of works, to be opened Feb. 21.

Chillicothe, Mo.—The plant of the Chillicothe Water Works, Electric Light & Gas Co. has been sold by Receiver W. E. Gunley, in the suit of the bondholders for default of interest, to Alexander G. Black, of New York, and president of the reorganized company, for $50,000. The estimated cost of the plant is $85,000. The works were built by Comegys & Lewis, of New York, and it is said were bonded to English capitalists for $200,000.

Marlin, Tex.—Thomas & Gorman, of Houston, Tex. have closed a contract for the erection of water-works, an ice factory and electric light plant combined, and are in the market for material and machinery.

Antonito, Col.—The Town Board is devising means to induce capitalists to put in a system of works for fire protection and domestic supply. One proposition is now under consideration.

Denver, Col.—The Denver Water Co. has asked for the passage of an ordinance granting them the right to lay and maintain water mains through the streets, with the necessary appurtenances, and set hydrants. Said right to be granted for a period of 20 years, from May 1, 1891. They also offer to pay the city $25,000 for the 493 hydrants already set, which it now owns, and to furnish a supply of pure water sufficient for all purposes.

San Pedro, N. M.—The company has secured a good supply of water from its 6 by 8 ft. well at a depth of 76 ft. Water will be pumped from this well to an elevated reservoir; thence by gravity to supply the town. F. A. Blake is Secretary of San Pedro Town Co.

PACIFIC.

Pullman, Wash.—We have received the following information from Thomas Neill:

The proposed plan is to construct works costing about $10,000, the town issuing bonds. Water would probably be conveyed by gravity from artesian wells to a reservoir, and be used for fire protection and domestic supply. Nothing will be done until a law is passed in conformity to the constitution regarding bonding towns. It is proposed to have the works completed by fall.

Olympia, Wash.—The Olympia Water Co. has sold its interests to E. W. Andrews, of Cincinnati, W. F. Newell, of St. Paul, and E. L. Sawyer, of Tacoma, for $50,000. The company intend increasing the present stock to $100,000, and establishing a complete system of works.

Tacoma, Wash.—The Council has ordered the City Engineer to prepare estimates for a new system of works to be built by the city. An analysis of the present supply has shown it to be impure and unfit for use.

Seattle, Wash.—About 25 additional hydrants will be placed at once. The city has agreed to pay the Spring Hill Water Co. $2,265.67 to bind the purchase of its plant, and to leave $350,000 to be paid at such time as the city is authorized by the Legislature to issue bonds for full payment. If this plan is adopted, extensions and improvements made from now until the trade is consummated by the full payment, will be done by direction of the City Council, and by advice and under the supervision of Benezette Williams, Consulting Engineer. The city will furnish the material for the extensions, and the Spring Hill Water Co.'s force will do the work, and render monthly accounts to the city. Bids are wanted at once for furnishing two pumping engines, each having a daily capacity of 2,500,000 gallons.

Dallas, Ore.—Bids will be received until March 1 for $100,000 of water bonds; $25,000 payable in 5 years, $25,000 in 10 years, $25,000 in 15 years and $25,000 in 20 years. M. T. Nolan is Secretary of the Board of Water Commissioners.

East Portland, Ore.—C. H. Rafferty, H. C. Meyer, John H. Hall, and others, have been appointed as committeemen to consider the feasibility of the city owning its own works. The East Portland Water Co. has since submitted a proposition to supply water at reduced rates, enlarge their plant, and deliver Crystal Springs water.

Moscow, Idaho.—Contractor Sutherland, of Walla Walla, will commence work as soon as the weather will permit. The esimated cost of the works is $25,000.

CANADA.

Montreal, P. Q.—Sealed proposals marked "Tenders for Lead" will be received on Feb. 11, for 50 tons (ton of 2,240 lbs.)of the best soft "Llanelly" pig lead, to be delivered. Tenders addressed "Tenders for valves," will also be received for 5 24-in. valves, to be made from patterns, drawings and specifications to be furnished by the water department. Also bids marked "Tenders for Tubing" until Feb. 18, for 6,000 lbs. of solid, drawn, brass tubing, 3-16 in. external diameter, to stand 15 lbs. atmospheric pressure. Address B. D. McConnell, Superintendent.

FOREIGN.

Havana, Cuba.—Ground was broken for the new works on Jan. 31. They are to be constructed by Runkle, Smith & Co., of New York, at an estimated cost of $2,000,000. Daniel Runkle, H. G. Runkle, R. A. C. Smith and other Americans interested in the enterprise are upon the ground, and will superintend their construction.

ARTESIAN WELLS.

Fort Worth, Tex.—Bids for sinking a well will be received by the Mayor.

Madison, So. Dak.—The town has advertised for bids for sinking a well.

IRRIGATION.

Albuquerque, N. M.—The Rio Puerco Irrigation & Agricultural Co. has been incorporated; capital stock, $2,500,000. The directors are: Charles W. Lewis, Mariano S. Otero, Thomas B. Catron and others.

Turlock, Cal.—H. W. Gray, of Sausalito, has been awarded the contract for building four miles of the Turlock District Irrigating Canal.

Denver, Col.—Bids are wanted by W. C. Bradbury & Co., Room 56, Railroad Building, Denver, for constructing 100 miles of irrigating canal, the contract to let at once, in sections. This work is located along the Arkansas River, commencing 25 miles east of Pueblo, Col.; dry, sandy soil, no frost, no snow; extreme free haul, 100 ft., then pay both ways; cheap hay and grain. Prices: Earth, 9 to 12 cts. per cu. yd.; loose rock, 25 cts. per cu. yd.; solid rock, 85 cts. per cu. yd.

Modesto, Cal.—The Board of Directors of the Modesto Irrigation District have sold $400,000 of irrigation bonds to I. R. Wilbur, of San Francisco, at 91 cts. on the dollar, thereby insuring the building of a canal in this district under the Wright law. Engineer Brooks has the plans and specifications nearly completed, and the advertisements for letting the contracts will soon be published. The district comprises 88,000 acres.

Denver, Col.—The Watkins Canal & Conduit Co. has filed articles of incorporation, and is to have a paid-up capital of $100,000. The directors for the first year are: Charles O. Green, Charles F. Calvis, Alexis S. King, Hiram C. Osborne and Brinton Gregory. The company proposes to build seven ditches in Arapahoe and Weld counties. The first or principal canal is to be taken out at Box Elder Creek, and by a system of canals and reservoirs will irrigate a large tract of land that has hitherto been barren.

SEWERAGE AND MUNICIPAL.

Drainage.—At Racine, Wis., engineers have completed plans for draining about 500 acres of swamp land in the vicinity of Franksville. Work will soon be commenced, as enough signatures in favor of the scheme have already been obtained, and it is said that the land to be reclaimed is worth $25,000. The ditch will be 6 ft. wide, 3 ft. deep and 3 miles long, and will convey the surplus water to Root River. It is proposed to drain the swamp lands in Bibb County, Ga., below Macon.

Sewers and Streets.—*Manchester, N. H.*—During last year more sewer and street work was done than usual, and considerable work is contemplated for the current year.

Gloucester, Mass.—The Legislature is to be petitioned for permission to construct a sewerage system.

Brockton, Mass.—The present system of sewage disposal is expensive and unsatisfactory, and it is proposed to build a complete system of sewerage and sewage disposal works.

New Bedford, Mass.—The town has appropriated $83,000 for streets, and $14,715 for sewers.

Stratford, Conn.—It has been decided to spend not more than $5,000 per annum for macadamizing.

Pittsburg, Pa.—Ordinances have been passed for grading, paving, curbing and sewers on several streets.

Chattanooga, Tenn.—Several sewers are to be built this year. For particulars address the Mayor.

Macon, Ga.—The City Engineer is preparing plans for the sewers and street improvements, for which $200,000 of bonds are to be issued.

Atlanta, Ga.—Ordinances have been passed authorizing the construction of brick sewers and pipe sewers. For particulars address A. P. Woodward, City Clerk.

Talladega, Ala.—Plans and estimates are being prepared for the new sewerage system.

Cincinnati, O.—Sewers and drains are to be built on Clifton Ave. and June St. For particulars address E. Henderson, City Clerk.

Grand Forks, Dak.—The question of establishing a sewerage system is being discussed.

Argentine, Kan.—A special committee appointed sometime ago by the Mayor to investigate the bond proposition reported that it would be necessary to issue at least $50,000 worth of bonds to pay for the work contemplated in the ordinance. Following are the estimates: Metropolitan Ave. sewer, $9,014.50; Strong Ave. sewer, $26,607.50; city hall, fire department and police station, $10,000; condemnation of property for sewers, $1,378; viaduct across the Santa Fé tracks, $3,000. The report was received and adopted and the city attorney was instructed to draft an ordinance calling for a special election.

Denver, Col.—The city engineer has presented to the Board of Public Works estimates for stone and combination paving. The latter is asphalt roadway with stone gutters. Both are to be on a concrete base 6 ins. thick. Stone is estimated at about $4 and asphalt at $3.50 per yard.

Great Falls, Mont.—A report to the sewerage committee has been made by Mr. G. N. Miller, consulting engineer.

An approximate estimate of main sewer on Third St. from the alley between First and Second Ave. south to the Missouri River, is as follows:

3,960 lin. ft. of 30-in. oval cement pipe at $2.50	$9,900
50 branches for house connections at 50 cts.	25
9 brick manholes with cast-iron covers at $100	900
3,960 lin. ft. of pipe laying at 10 cts.	396
4,600 cu. yds. of earth excavation and back filling at 60 cts.	2,400
1,610 cu. yds. of loose rock excavation and back filling at $1.25	2,050
1,000 cu. yds. of solid rock excavation at $3	3,000
Total	$18,691
Add 10 per cent. for engineering and contingencies	1,869
Grand total	$20,560

This main sewer will drain, when the laterals are built, an area of about 800 acres, including the part of the city already built up, and would be sufficient for a population of 30,000 inhabitants. This section is part of a natural drainage area of about 2,500 acres, all of which could be drained by one trunk sewer; but this would require a sewer of about 4½ ft. in diameter, at an expenditure of not less than $50,000. When the main sewer on Third St. is built from the river to the south line of the town site, it will require about 10 miles of lateral sewers to drain this district, at a cost of about $7,000 per mile. As the city is laid out uniformly, with alleys through every block, it was considered economical to locate the sewers in the alleys, instead of the avenues, as by so doing the length of the house drains will be reduced, and a less depth of the lateral sewers is required.

St. John, N. B.—The city will apply to the Legislature for further power in the matter of sewerage.

Steam Heat.—The Seattle Steam Heat and Power Co., of Seattle, Wash., has let the contract for its mains and plant to Murphy & Wright, for $50,000. The mains will be large enough to allow an extension of the system one block in any direction. The steam main at the power-house will be 14 ins. in diameter, and the water mains 12 ins. These pipes will be reduced in size as the branch for the different buildings are taken off. They will be placed below the gas and water pipes, and the steam pipes will be solidly imbedded in brick conduits lined with a non-conductor. A low pressure of steam will be kept up at all times. The water power which the company will furnish will not only supply power to run the twenty elevators in the buildings which are in the system, but will also furnish powerful and efficient fire-protection.

Gasoline.—The contract for lighting the streets at St. Paul, Minn., with gasoline, has been let to Robert Seeger at $14.40 per lamp per year for three years.

Gas Works.—At Great Falls, Mont., a franchise has been granted to a gas company, which will have its plant in operation by July.

ELECTRICAL.

Electric Lighting.—*Madison, N. J.*—It is proposed to establish an electric light plant.

Crisfield, Md.—A proposition has been made to put in electric light. Mr. L. R. T. Dixon is interested.

Salem, Va.—The Salem Electric Light & Power Co. has been incorporated. President, E. A. Parsons; Superintendent, G. Noyes.

Cordele, Ga.—The city has voted to put in an electric light plant, in connection with the water-works. The plant will be owned and operated by the city. Only incandescent lights will be used at present. Councilman D. J. McRae is at the head of the committee to consider the matter.

Crystal Springs, Mich.—Contracts will soon be let for an electric light plant.

St. Paul, Minn.—The committee on streets has been instructed to take the necessary steps to reduce the price of gas, etc., consumed by the city, also to report whether it is advisable or not to light the city by electricity or other methods to bring about this reduction, the same as now being done in Eastern cities; also to report whether or not competition is necessary to bring about this reduction or change in method of lighting.

Searcy, Ark.—It is proposed to put in an incandescent plant with a capacity of 300 lights. Mr. W. T. Carter is interested.

Albina, Ore.—The Albina Light & Water Co., capital stock, $50,000, will put in an Edison electric light plant.

BRIDGES, TUNNELS, AND CANALS.

Bridges.—*Grand Trunk Ry.*—This company will receive proposals until Feb. 10, for the construction of the masonry of certain bridges and culverts to be built on the Great Western and the Northern & Northwestern Divisions of its lines. Address Jas. Hickson, General Manager, Montreal, P. Q.

Rigaud, P. Q.—The Vaudreuil & Prescott Ry. Co. has made application to the Privy Council of the Dominion for authority to build a bridge across the Riviere a la Graisse at this place. J. Stubbs, Secretary and Treasurer, Montreal, P. Q.

St. Stephens, N. B.—The Shore Line Ry. Co. is petitioning for power to build a bridge across the St. Croix River near this place.

Brattleboro, Vt.—The bridge being built across the West River by the Vermont Valley R. R. Co. is nearly completed, the flooring and track only remaining to be finished. The bridge is a pier-jointed, half-deck structure, having a main span of 292 ft., the compression members having an ultimate strength of 50,000 lbs. per sq. in.

New Jersey.—The Barnes Iron Bridge and Fence Co., has been incorporated in New Jersey, by Lewis Barnes, Wm. S. Nichols and S. C. Woodhull. Capital, $500,000.

Harrisburg, Pa.—The Harrisburg Terminal Co., has been granted the right to build a bridge across the Susquehanna River for the Philadelphia & Reading R. R. It is announced that it will be built at once.

Baltimore, Md.—Good progress is being made on the construction of the bridge over Jones Falls, at Cedar avenue. The bridge is being built by the King Iron Bridge Manufacturing Co., of Cleveland, O., at a cost of $30,000. It will consist of two girder spans of nearly 80 ft. each over the Falls road and Northern Central R. R. tracks, two girder spans of 24 ft. each within the park, & a braced arch span of 150 ft. over Jones Falls. The abutments and piers are of ashler masonry.

Lovettsville, Va.—A bill has been introduced into the Virginia State Legislature, to incorporate the Berlin & Lovettsville Bridge Co. to build a bridge across the Potomac River. Among the incorporators are: Daniel Baker, Jr., D. H. Hargett, and R. H. Gibbs, of Lovettsville.

Riverton, Va.—A company is being organized to build bridges over the two branches of the Shenandoah River at this place.

Boonville, Ky.—The Pittsburg Bridge Co. has the contract for building an iron bridge across the south fork of the Kentucky River at this point.

Louisville, Ky.—Work is progressing rapidly on the bridge across the Ohio River between this place and Jeffersonville, Ind. The work on the piers is about one-fourth done. The caisson of pier 5, where the accident recently occured, is now about 40 ft. below low water mark. The caissons for piers 3 and 4 are nearly finished, and will soon be sunk. Pier 2 is now built about 50 ft. above the water and pier 1 is nearly completed.

East St. Louis, Ill.—The Missouri Valley Co. has a large force of men at work on the Broadway Viaduct. Both piers at Cahokia Creek are nearly finished, and work will shortly begin on the superstructure.

St. Paul, Minn.—The City Council has approved the contracts for the construction of the iron bridge and approaches on the Mendota road in Dakota Co., and also for the construction of the wooden Howe-Truss bridge over the right of way of the Chicago, Milwaukee & St. Paul Ry. Co., on Grand Ave, in the City of St. Paul.

La Crosse, Wis.—The contract for building the steel highway bridge across the Mississippi River at this point has been let to the Clinton Bridge and Iron Co., of Clinton, Ia., for $83,000.

Clinton, Ia.—The Clinton Bridge and Iron Co., of Clinton, La., has secured the contract for the highway bridge from the north part of Clinton, Ia., to Stoney Point, over the Mississippi River. The bridge is to cost $165,700.

Morrillton, Ark.—Bids will be received for the construction of an iron bridge 100 ft. long at this place. Address M. P. McReynolds, Morrillton.

Pendleton, Ark.—A bridge to cost $10,000 is to be built over the Umatilla River at this place.

San Antonio, Tex.—Bids will be received until Feb. 15 for the construction of 3 open truss bridges over the San Antonio River. Address Bryan Callaghan, Mayor, San Antonio.

Travis County, Tex.—Proposals will be received for the construction of a bridge over Manchacca Creek, in Travis County, Tex. J. M. Breckenridge, County Judge, Austin, Tex.

Proposed.—Bridges are proposed at Norfolk, Va.; Greenville, N. C.; Couchville, Tenn.; Memphis, Tenn., and Newport, Ark.

Tunnels.—*New York, N. Y.*—A bill has been introduced into the State Legislature providing for the construction of a tunnel under the Harlem River, beginning at 138 St. and Linden Ave. and running south along the east line of Linden Ave. to the Harlem River, and thence under the river to the east line of Second Ave. The cost is to be $5,000,000.

CONTRACTING.

Sewer.—The contract for the two sections of the Lick Run sewer at Cincinnati, O., has been awarded by the Board of Public Affairs to M. Peter & Son. The totals of the bids were as follows:

M. Peter & Son	$82,454.90	$100,230.00
Rockford Construction Co	106,323.00	116,632.50
W. C. McMurray	84,160.80	113,681.50
H. McErlane	90,819.50	115,512.50
Kirchner & Scully	92,958.50	124,630.00
A. F. Minahan	87,577.00	102,133.00
P. N. Jonte	84,393.00	103,636.00
Henkel & Brehm	100,377.30	138,835.00
Geo. H. Meyer	101,711.00	124,030.00

The contract prices were as follows: 1,540 lin. ft. 14-ft. sewer, $3,234; 810 lin. ft. 13-ft. sewer, $16,200; 150 lin. ft. 9-ft. sewer, $1,923.90; 100 lin. ft. 5-ft. sewer, $480; 200 lin. ft., 4-ft. sewer, $876; 150 6-in. slants, $60; 50 8-in. slants, $30; 100 lin. ft. 12-in. pipe, $50; 100 lin. ft. 15-in. pipe, $65; 100 lin. ft. 18-in. pipe, $80; 100 lin. ft. 21-in. pipe, $115; 100 lin. ft. 24-in. pipe, $180; 5 man-holes, $140; 15,000 cu. yds. excavation, $14,250; 21,000 cu. yds. extra refilling, $6,300; 2,000 cu. yds. rubble masonry, $7,500; 500 cu. yds. concrete, $1,625; 20,000 ft. B. M. sheeting, $100; total, $82,454.90.—2,500 lin. ft. 14-ft. sewer, $52,500; 100 lin. ft. 3-ft. sewer, $310; 150 6-in. slants, $60; 50 8-in. slants, $30; 100 lin. ft. 12-in. pipe, $50; 100 lin. ft. 15-in. pipe, $65; 100 lin. ft. 18-in. pipe, $80; 100 lin. ft. 21-in. pipe, $115; 100 lin. ft. 24-in. pipe, $180; 5 manholes, $140; 23,000 cu. yds. excavation, $21,850; 4,000 cu. yds. rubble masonry, $15,000; 3,000 cu. yds. concrete, $9,750; 100,000 ft. B. M. sheeting, $240; total, $100,230.

Canal Lock Machinery.—The contract for placing machinery in thirteen locks of the Erie canal has been awarded by Edward Hannan, Superintendent of Public Works, Albany, N. Y., to N. & W. H. Wemple, of Fultonville, N. Y., at $7,700 per lock.

Iron Poles.—The following proposals were received Jan. 27 by the Cincinnati St. Ry. Co., of Cincinnati, O., for 550 poles made of iron pipe, for the Avondale electric line: Wm. Kirkup & Son, $19.49 each for 500 to 550 poles delivered along the route; Richard Ellison, $19.50, poles not to specification; F. J. P. Brackett Bridge Co., $19.85, delivered at shops; Crane & Co., Chicago, $20 poles not to specifications; Queen City Bridge Co., $21.55, delivered along route; Statham & Percival, $20.95, delivered at shops; E. A. Stimson & Co., $22.50, delivered along route; E. Schrieber & Sons Co., $24.45, delivered along route; McHose & Lyon, $27.50, delivered along route. The contract was awarded to Wm. Kirkup & Son.

Dredging.—The following proposals were opened Jan. 20, by Major A. N. Damrell, U. S. Engineer Office, Mobile, Ala.:

Biloxi Bay: Alabama Dredging & Jetty Co., Mobile, Ala., 14⅝ cts. per cu. yd.; Geo. C. Fobes & Co., Baltimore, Md., 15 2-10 cts.

Pascagoula River: J. H. Gardner, New Orleans, La., 27 cts. per cu. yd.: Alabama Dredging Jetty & Co., Mobile, Ala., 17⅛ cts.; Geo. C. Fobes & Co., Baltimore, Md., 16 2-10 cts.

Pascagoula Dam: J. H. Gardner, New Orleans, La., plan A, $4,869; plan B, $7,547; Alabama Dredging & Jetty Co., Mobile, Ala., plan A, $3,350; John Hogan, Mobile, Ala., plan A, $4,743.

Public Buildings.—Plans have been accepted for the new court house at Red Oak, Ia., to cost $75,000. Proposals will shortly be advertised for. A new county jail is to be built at Santa Rosa, Cal., by the Supervisors. A county court house is to be built at Pierce, Neb., at a cost of $25,000. The contract for the new county jail at Santa Rosa, Cal., has been let to Bigelow & Little, of San Francisco, at $34,700.

Iron Work.—The following proposals for iron work for the State House extension have have been received by the State House Commissioners, Boston, Mass:

Norcross Bros., Worcester, Mass., $171,904.
L. M. Ham & Co., Boston, Mass., $172,797.
Smith & Carlton Iron Co., Boston, Mass., $173,854.
Frank L. Froment, Boston, Mass., $185,350.
Cheney & Hewlett, New York, $174,863.
Joel Knapp & Son, Lowell, Mass., $225,205.
Haugh, Ketchum & Co., Indianapolis, Ind., $161,300.
Megquier & Jones, Portland, Me., $152,798.
G. W. & F. Smith Iron Co., Boston, Mass., $174,900.
Builders' Iron Foundry, Providence, R. I., $168,000.

The work includes 1,850 tons of wrought-iron beams, riveted girders, etc., and 600 tons of cast-iron columns.

Gravel.—The following proposals have been received by J. K. Cotton, Street Commissioner, Newport, R. I., for supplying gravel during the year: C. T. Derry & Co., Newport, 58 cts. per ton; J. T. Knull, 58¼ cts.; Connolly & Walsh, 72 cts.; E. O. Riggs, 75 cts.; J. S. Anthony, 83 cts.; Brown & Howard, 85 cts. The contract has been awarded to C. T. Derry & Co.

Dam.—Proposals were opened Feb. 5 by the Aqueduct Commissioners, New York City, for the dam for reservoir M. The names of bidders and totals of bids are given in our "Water-Works" columns, and we shall give the full list of detail prices next week.

PROPOSALS OPEN.

Road Work.—Improving county roads; grading, gutters and macadam roadway. The District Commissioners, Washington, D. C. Feb. 10.

Lighthouses.—Metal work for two lighthouses. Capt. J. C. Mallery, U. S. Lighthouse Engineer, Baltimore, Md. Feb. 12.

Castings.—About 79 tons of special castings and service boxes, and 40 tons of sewer castings. John A. Coleman, Commissioner of Public Works, Providence, R. I. Feb. 12.

Street Material.—Flag stones, Belgian blocks, cobble stones, gutter stones, also iron gutter plates. A. E. Smyrk, City Commissioner, Baltimore, Md. Feb. 14.

Street Work.—Paving, grading, repairing streets and sidewalks; constructing culverts; furnishing broken stone, bricks and gravel. Louis Wagner, Director of Public Works, Philadelphia, Pa. Feb. 15.

City Work.—About 50,000 lin. ft. of curbing, 50,000 cu. yds. of excavation for street grading; 30,000 lin. ft. of 8 to 24-in. vitrified sewer pipe; 10,000 bbls. of cement. R. M. Clayton, City Engineer, Atlanta, Ga. Feb. 17.

Pipe Line.—Materials and work for the completion of the North Denver pipe line. F. B. Crocker, President Board of Public Works, Denver, Col. Feb. 17.

Street Work.—Excavating, filling, curbing, flagging and cobblestone paving. Thos. J. Lanahan, Clerk, Board of Contract and Apportionment, Albany, N. Y. Feb. 17.

Lighthouse.—Metal work of lighthouse on the Maine coast. Major W. S. Stanton, U. S. Lighthouse Engineer, Boston, Mass. Feb. 18.

Stone.—About 16,500 cu. yds. of 2½-in. broken trap-rock stone, 7,000 cu. yds. of trap-rock screenings, 2,500 cu. yds of screened gravel. The Department of Public Parks, 49 Chambers St., New York City. Feb. 19.

Asphalt Paving.—About 3,000 sq. yds. F. E. Rebarer, City Clerk, Savannah, Ga. Feb. 25.

Bridges.—Three wooden bridges across the cut now being made from Chincoteague Bay to Indian River Bay, Delaware. Gen. W. F. Smith, U. S. Engineer Office, Wilmington, Del. March 6.

MANUFACTURING AND TECHNICAL.

Sewer Pipe Prices.—H. A. Warner, of New Haven, Conn., has issued a card of prices for 3 to 24-in. Ohio vitrified sewer pipe, bends, branches, etc. The weights and prices per ft. of pipe are as follows: 3-in., 6 lbs., 16 cts.; 4-in., 9 lbs., 20 cts.; 5-in., 12 lbs., 25 cts; 6-in., 17 lbs., 30 cts.; 8-in., 24 lbs., 45 cts.; 9-in., 28 lbs., 55 cts.; 10-in., 33 lbs., 65 cts.; 12-in., 45 lbs., 85 cts.; 15-in., 60 lbs., $1.25; 18-in., 78 lbs., $1.70; 20-in., 100 lbs., $2.25; 24-in., 136 lbs., $3.25.

Pole Road.—Pole road equipment, with 1 engine and 6 cars, is wanted by Stone & Grier, Beech Hill, Ga.

Locomotives.—The Richmond Locomotive & Machine Works, of Richmond, Va., have completed an order for 5 consolidation engines for the Richmond & Danville; cylinders, 20 x 24 ins.; driving wheels, 50 ins.; driving wheel-base, 14 ft.; total wheel-base, 21 ft., 6 ins.; weight in working order, 106,000 lbs. on driving wheels; total, 120,000 lbs.; total weight of engine and tender, 190,000 lbs. Two consolidation engines are being built for the Chesapeake & Ohio; cylinders, 21 x 24 ins. Some other locomotives of smaller size are also under construction. This firm has the contract for the engines, boilers and machinery for the U. S. battle-ship *Texas*.

The Baldwin Locomotive Works, of Philadelphia, Pa., are building 75 engines for the Northern Pacific. Two freight engines have been delivered to the Boston & Albany.

The Portland Co. is building 4 engines for the Maine Central; weight, 55 tons each.

The Brooks Locomotive Works, of Dunkirk, N. Y., have an order for 20 ten-wheel freight engines for the Lake Shore & Michigan Southern.

Cars.—The Laclede Car Co., of St. Louis, Mo., is building 24 grip and 24 tow cars for the Washington & Georgetown cable road, at Washington, D. C.; cable cars for Los Angeles, Cal., and a number of electric and horse cars.

The St. Louis Car Co., of St. Louis, Mo., is building two steam motors for Portland, Ore.; they are 36 ft. long. Also 70 electric and 34 horse cars.

The Pullman Palace Car Co., of Chicago, Ill., has a large order for cars for the Northern Pacific.

Cars for the dummy line of the Chamberlain Investment Co., Forth Worth, Tex., will be purchased by P. P. Ford, the contractor for the road.

Boilers.—At Cincinnati, O., an appropriation of $5,500 has been made for boilers for the Work House.

Electric Locomotive.—A storage battery electric engine is to be tried on the Michigan Central.

The Bucyrus Steam Shovel & Dredge Co., of Bucyrus, O., has received an order for three large railway steam shovels from the Lake Shore & Michigan Southern Ry., making seven shovels furnished by them to this road. Two of the shovels furnished are among the heaviest and strongest ever built, carrying a 3-yd. dipper, and having a capacity of over 3,000 cu. yds. in 10 hours.

Steel Cars.—The Steel Car Co. will erect extensive works at Harvey, Ill., for the construction of cars entirely of steel. The paneling will be of steel, with asbestos lining and a decorated surface. About 700 acres of land have been purchased, and 250 acres will be used for the works, while the remainder will be for residences, it being intended to establish a town on the same principle as Pullman, Ill. The plans have been made for foundry, machine shop, blacksmith shop, car and erecting shops. The shops will be in two long buildings, 1,450 and 1,500 ft. long, 115 ft. wide. A mail car built on this company's plans has been in service for some time on the Louisville, New Albany & Chicago Ry.—The Steel Tubular Car Co. has purchased land for the erection of works near Bradford, Pa. The company owns the patents for the J. W. Post cars, and is said to have a large order from the Pennsylvania R. R.

The South Baltimore Car Co., of Baltimore, Md., is doing a good business. The work at present is limited to freight and cattle cars, but it is proposed to erect new shops for the construction of passenger cars. The works were opened in January, 1888, and have turned out 3,236 cars in two years; orders for 800 cars are now on hand. The buildings include an erecting shop 357 ft. long, 84 ft. wide, 37 ft. high; saw shop, 251 by 45 ft., 26 ft. high; foundry, 202 by 84 ft., 33 ft. high; machine and blacksmith shops, each 169 by 45 ft.; truck shop, 100 by 45 ft. The capacity of the works is from 12 to 15 cars per day. During 1889 the output was 1,621 cars. The company has a capital stock of $200,000. President, John B. McDonald; Secretary and Treasurer, Charles T. Crane; Manager, Howard Carlton.

Car Works.—At Atlanta, Ga., the question of establishing car works has been considered by the Chamber of Commerce. The committee appointed to discuss the matter and to report on the organization of a company for the erection of car works, to build and repair railway cars, has recommended that a committee be appointed from the Chamber of Commerce to procure a charter for said works, with a capital of $250,000, with authority to increase the same from time to time to an amount not to exceed $1,000,000, and that said company be authorized to organize and commence business when $100,000 of the capital stock is subscribed.

Gas Engines.—The American Gas Engine Co., of Chicago, has been incorporated by Charles Fellows, C. W. Annable and H. C. Johnson. Capital stock, $200,000.

Railway Construction for 1890.—We shall publish in a few weeks a map showing the railway construction which will probably be carried out during the present year.

Cement Works.—A plant to manufacture Portland cement, with a capacity of 200 bbls. per day, is to be built near San Diego, Cal. Warren Wilson and W. P. Adams, of San Diego, are interested.

The Ducker Portable House Co. is now located in the Star Building, 239 Broadway. The company reports business good.

Metal Market Prices.—*Rails.*—New York, $35 to $36. Chicago: $38; old rails, $25.50 for iron and $20 to $21.75 for steel. Pittsburg: $36; old rails, $28.50 for iron, $24 to $24.50 for steel.

Track Materials.—New York: steel and iron angle bars, $2.15; spikes, $2.20 to $2.25. Pittsburg: splice bars, 2.10 to 2.20 cts.; spikes, $2.15, or $2.25 delivered at Chicago or St. Louis; track bolts, 3.10 cts. with square and 3.20 cts. with hexagon nuts. Chicago: splice bars, 2.25 cts. for steel and 1.90 to 2 cts. for iron; spikes, 2.25 to 2.30 cts.; track bolts, 2.80 to 2.85 cts. with square and 2.95 to 3 cts. with hexagon nuts.

Pipe.—Cast iron, about $27 to $30 per ton, according to competition and amount of order. Wrought iron discounts as follows: 47½ per cent. on black butt-welded, 40 on galvanized butt-welded, 60 on black lap-welded, 47½ on galvanized lap-welded.

Lead.—New York, 3.80 to 3.85 cts.; Chicago, 3.65 cts.; St. Louis, 3.60 cts.

Dredge.—The Common Council Committee on Sewers Newark, O., has voted to secure bids on a dredger, to cost between $6,000 and $7,000.